Activity Report 2014

Section Partnerships and Cooperations

ALGORITHMICS, PROGRAMMING, SOFTWARE AND ARCHITECTURE

APPLIED MATHEMATICS, COMPUTATION AND SIMULATION

DIGITAL HEALTH, BIOLOGY AND EARTH

NETWORKS, SYSTEMS AND SERVICES, DISTRIBUTED COMPUTING

PERCEPTION, COGNITION AND INTERACTION

ANTIQUE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. AnaStaSec

Title: Static Analysis for Security Properties

Type: ANR générique 2014

Defi: Société de l'information et de la communication

Instrument: ANR grant

Duration: January 2015 - December 2018

Coordinator: Inria Paris-Rocquencourt (France)

Others partners: Airbus France (France), AMOSSYS (France), CEA LIST (France), Inria Rennes-Bretagne Atlantique (France), TrustInSoft (France)

Inria contact: Jérôme Feret

See also: http://www.di.ens.fr/ feret/anastasec/

Abstract: An emerging structure in our information processing-based society is the notion of trusted complex systems interacting via heterogeneous networks with an open, mostly untrusted world. This view characterises a wide variety of systems ranging from the information system of a company to the connected components of a private house, all of which have to be connected with the outside.

It is in particular the case for some aircraft-embedded computer systems, which communicate with the ground through untrusted communication media. Besides, the increasing demand for new capabilities, such as enhanced on-board connectivity, e.g. using mobile devices, together with the need for cost reduction, leads to more integrated and interconnected systems. For instance, modern aircrafts embed a large number of computer systems, from safety-critical cockpit avionics to passenger entertainment. Some systems meet both safety and security requirements. Despite thorough segregation of subsystems and networks, some shared communication resources raise the concern of possible intrusions.

Some techniques have been developed and still need to be investigated to ensure security and confidentiality properties of such systems. Moreover, most of them are model-based techniques operating only at architectural level and provide no guarantee on the actual implementations. However, most security incidents are due to attackers exploiting subtle implementation-level software vulnerabilities. Systems should therefore be analysed at software level as well (i.e. source or executable code), in order to provide formal assurance that security properties indeed hold for real systems.

Because of the size of such systems, and considering that they are evolving entities, the only economically viable alternative is to perform automatic analyses. Such analyses of security and confidentiality properties have never been achieved on large-scale systems where security properties interact with other software properties, and even the mapping between high-level models of the systems and the large software base implementing them has never been done and represents a great challenge. The goal of this project is to develop the new concepts and technologies necessary to meet such a challenge.

The project ANASTASECproject will allow for the formal verification of security properties of software-intensive embedded systems, using automatic static analysis techniques at different levels of representation: models, source and binary codes. Among expected outcomes of the project will be a set of prototype tools, able to deal with realistic large systems and the elaboration of industrial security evaluation processes, based on static analysis.

8.1.1.2. Verasco

Title: Formally-verified static analyzers and compilers

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: Septembre 2011 - September 2015

Coordinator: Inria (France)

Others partners: Airbus France (France), IRISA (France), Inria Saclay (France)

See also: http://www.systematic-paris-region.org/fr/projets/verasco

Abstract: The usefulness of verification tools in the development and certification of critical software is limited by the amount of trust one can have in their results. A first potential issue is *unsoundness* of a verification tool: if a verification tool fails (by mistake or by design) to account for all possible executions of the program under verification, it can conclude that the program is correct while it actually misbehaves when executed. A second, more insidious, issue is *miscompilation*: verification tools generally operate at the level of source code or executable model; a bug in the compilers and code generators that produce the executable code that actually runs can lead to a wrong executable being generated from a correct program.

The project VERASCOadvocates a mathematically-grounded solution to the issues of formal verifying compilers and verification tools. We set out to develop a generic static analyzer based on abstract interpretation for the C language, along with a number of advanced abstract domains and domain combination operators, and prove the soundness of this analyzer using the Coq proof assistant. Likewise, we will continue our work on the CompCert C formally-verified compiler, the first realistic C compiler that has been mechanically proved to be free of any miscompilation will be continued. Finally, the tool qualification issues that must be addressed before formally-verified tools can be used in the aircraft industry, will be investigated.

8.1.1.3. AstréeA

Title: Static Analysis of Embedded Asynchronous Real-Time Software

Type: ANR Ingénierie Numérique Sécurité 2011

Instrument: ANR grant

Duration: January 2012 - December 2015

Coordinator: Airbus France (France)

Others partners: École normale supérieure (France)

Inria contact: Antoine Miné

See also: http://www.astreea.ens.fr

Abstract: The focus of the ASTRÉEA project is on the development of static analysis by abstract interpretation to check the safety of large-scale asynchronous embedded software. During the THÉSÉE ANR project (2006–2010), we developed a concrete and abstract models of the ARINC 653 operating system and its scheduler, and a first analyzer prototype. The gist of the ASTRÉEA project is the continuation of this effort, following the recipe that made the success of ASTRÉE: an incremental refinement of the analyzer until reaching the zero false alarm goal. The refinement concerns: the abstraction of process interactions (relational and history-sensitive abstractions), the scheduler model (supporting more synchronisation primitives and taking priorities into account), the memory model (supporting volatile variables), and the abstraction of dynamical data-structures (linked lists). Patrick Cousot is the principal investigator for this project.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. MemCad

Type: IDEAS

Defi: Design Composite Memory Abstract Domains

Instrument: ERC Starting Grant

Objectif: Design Composite Memory Abstract Domains

Duration: October 2011 - September 2016

Coordinator: Inria (France)

Partner: None

Inria contact: Xavier Rival

Abstract: The MemCAD project aims at setting up a library of abstract domains in order to express and infer complex memory properties. It is based on the abstract interpretation frameworks, which allows to combine simple abstract domains into complex, composite abstract domains and static analyzers. While other families of abstract domains (such as numeric abstract domains) can be easily combined (making the design of very powerful static analyses for numeric intensive applications possible), current tools for the analysis of programs manipulating complex abstract domains usually rely on a monolithic design, which makes their design harder, and limits their efficiency. The purpose of the MemCAD project is to overcome this limitation.

Our proposal is based on the observation that the complex memory properties that need to be reasoned about should be decomposed in combinations of simpler properties. Therefore, in static analysis, a complex memory abstract domain could be designed by combining many simpler domains, specific to common memory usage patterns. The benefit of this approach is twofold: first it would make it possible to simplify drastically the design of complex abstract domains required to reason about complex softwares, hereby allowing certification of complex memory intensive softwares by automatic static analysis; second, it would enable to split down and better control the cost of the analyses, thus significantly helping scalability. As part of this project, we propose to build a static analysis framework for reasoning about memory properties, and put it to work on important classes of applications, including large softwares.

8.2.1.2. MBAT

Title: Combined Model-based Analysis & Testing of Embedded Systems

Type: Artemis Call 10

Instrument: FP7 project

Duration: November 2011 - October 2014

Coordinator: Daimler (Germany)

Others partners: 38 partners in Austria, Denmark, Estonia, France, Germany, Italy, Sweden, and United Kingdom

See also: https://artemis-ia.eu/project/29-mbat.html

Abstract: MBAT will mainly focus on providing a technology platform for effective and cost-reducing validation and verification of embedded systems, focusing primarily on transportation domain, but also to be used in further domains. The project involves thirty three European industrial (large companies and SMEs) and five academic partners. Radhia Cousot is the principal investigator for this project.

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. EXEK

Title: EXEcutable Knowledge

Type: DARPA

Instrument: DARPA Program

Program: Big Mechanism

Duration: July 2014 - December 2017

Coordinator: Harvard Medical School (Boston, USA)

Partner: Inria Paris-Rocquencourt, École normale supérieure de Lyon Université Paris-Diderot,

Inria contact: Jérôme Feret

Abstract: Our overarching objective is Executable Knowledge: to make modeling and knowledge representation twin sides of biological reasoning. This requires the definition of a formal language with a clear operational semantics for representing proteins and their interaction capabilities in terms of agents and rules informed by, but not exposing, biochemical and biophysical detail. Yet, to achieve Executable Knowledge we need to go further:

- Bridge the gap between rich data and their formal representation as executable model elements. Specifically, we seek an intermediate, but already formal, knowledge representation (meta-language) to express granular data germane to interaction mechanisms; a protocol defining which and how data are to be expressed in that language; and a translation procedure from it into the executable format.

- Implement mathematically sound, fast, and scalable tools for analyzing and executing arbitrary collections of rules.

- Develop a theory of causality and attendant tools to extract and analyze the unfolding of causal lineages to observations in model simulations.

We drive these technical goals with the biological objective of assembling rule-based models germane to Wnt signaling in order to understand the role of combinatorial complexity in robustness and control.

8.3.2. Inria International Labs

Xavier Rival attended the LIAMA Open Day in July 2014, gave a talk on "Modular Construction of Shape-Numeric Analyzers" and participated to the associated Summer School, giving a one day introduction to Verification by Abstract Interpretation.

8.3.3. Inria International Partners

8.3.3.1. Informal International Partners

Research on abstract domains for memory states involves the group of Bor-Yuh Evan Chang (University of Colorado at Boulder, Colorado, USA).

Research on sensitivity is done in partnership with the group of Sukyoung Ryu (Assistant Professor at KAIST, Daejeon, Korea).

Research on numeric abstract domain is done in partnership with the groups of Ji Wang and Liqian Chen (National University of Defense Technology, Changsha, China) and of Deepak Kapur (University of New Mexico, USA).

8.4. International Research Visitors

8.4.1. Visits of International Scientists

Kwangkeun Yi (Professor at Seoul National University, Seoul, Korea) visited the group during two weeks in June-July 2014. Sukyoung Ryu (Assistant Professor at KAIST, Daejeon, Korea) visited the group during four weeks in July-August 2014.

8.4.2. Internships

Benjamin Audry accomplished a under the supervision of Jérôme Feret (while he was a student at "Collège du Parc", Sucy en Brie, France).

Pretesh Agrawal accomplished a pre-doctoral internship undern the supervision of Jérôme Feret and Norman Ferns (while he was a fourth year undergraduate student at IIT Kanpur, India).

Émile Ferreux and Nessim Morsli accomplished under the supervision of Jérôme Feret (while they were L1 student of the FDV Bachelor program, Frontiers in Life Science, at University Paris-Descartes, France).

Huisong Li accomplished a pre-doctoral internship under the supervision of Xavier Rival (while she was a student at the Institute of Software, at the Chinese Academy of Sciences (Beijing, China).

Thibault Suzanne accomplished a Master internship under the supervision of Antoine Miné.

Abdelraouf Ouadjaout, a PhD student at CERIST Research Center (Alger), performed a one-month internship in the group under the supervision of Antoine Miné. The internship was funded by the Ministry of Higher Education and Scientific Research of Algeria.

<p align="center" style="color:red">AOSTE Project-Team</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. CIM PACA Design Platform

Participants: Robert de Simone, Ameni Khecharem, Carlos Gomez Cardenas, Emilien Kofman.

This ambitious regional initiative is intended to foster collaborations between local PACA industry and academia partners on the topics of microelectronic design, though mutualization of equipments, resources and R&D concerns. We are active in the Design Platform (one of three platforms), of which Inria is a founding member. This provides opportunities for interactions with local companies, leading indirectly to more formal collaborations at times. Phase 3 of the CIM PACA programme should be launched in 2015, and was subject of extensive preparation at the end of 2014.

The ANR HOPE project 8.2.1.1 is conducted under the auspices of the CIM PACA Design Platform, which also hosts prototype and commercial software products contributed by project members (Synopsys, Docea Power, and Magillem, see 8.2.1.1). Similarly, the CLISTINE FUI project was labeled by the platform as microelectronic branch of the SCS competitiveness cluster.

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. HOPE

Participants: Carlos Gomez Cardenas, Ameni Khecharem, Emilien Kofman, Robert de Simone.

The ANR HOPE project focuses on hierarchical aspects for the high-level modeling and early estimation of power management techniques, with potential synthesis in the end if feasible.
Although this project was officially started in November 2013, it was in part postponed due to the replacement of a major partner (Texas Instruments) by another one (Intel). Current partners are CNRS/UNS UMR LEAT, Intel, Synopsys, Docea Power, Magillem, and ourselves. A publication on multiview modeling (including performance, power, and temperature) was presented at FDL'2014, reflecting Ameni Khecharem ongoing PhD work.

8.2.1.2. GeMoC

Participants: Matias Vara Larsen, Julien Deantoni, Frédéric Mallet.

This project is admistratively handled by CNRS for our joint team, on the UMR I3S side. Partners are Inria (Triskell EPI), ENSTA-Bretagne, IRIT, Obeo, Thales TRT.
The project focuses on the modeling of heterogeneous systems using Models of Computation and Communication for embedded and real-time systems, described using generic means of MDE techniques (and in our case the MARTE profile, and most specifically its Time Model, which allows to specify precise timely constraints for operational semantic definition).

8.2.2. FUI

8.2.2.1. FUI P

Participants: Abderraouf Benyahia, Dumitru Potop Butucaru, Yves Sorel.

The goal of project P is to support the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework able to verify the semantic consistency of systems described using safe subsets of heterogeneous modeling languages, then to generate optimized source code for multiple programming (Ada, C/C++) and synthesis (VHDL, SystemC) languages, and finally to support a multi-domain (avionics, space, and automotive) certification process by providing open qualification material. Modeling languages range from behavioural to architectural languages and present a synchronous and asynchronous semantics (Simulink/Matlab, Scicos, Xcos, SysML, MARTE, UML),

See also: http://www.open-do.org/projects/p/

Partners of the project are: industrial partners (Airbus, Astrium, Continental, Rockwell Collins, Safran, Thales), SMEs (AdaCore, Altair, Scilab Enterprise, STI), service companies (ACG, Aboard Engineering, Atos Origins) and research centers (CNRS, ENPC, Inria, ONERA).

8.2.2.2. FUI CLISTINE
Participants: Robert de Simone, Amin Oueslati, Emilien Kofman.

This project was started in Oct 2013, aprovides PhD funding for Amine Oueslati. Partners are SynergieCAD (coordinator), Avantis, Optis, and the two EPIs Aoste and Nachos. The goal is to study the feasibility of building a low-cost, low-power "supercomputer", reusing ideas from SoC design, but this time with out-of-chip network "on-board", and out-of-the-shelf processor elements organized as an array. The network itself should be time predictable and highly parallel (far more than PCI-e for instance). We started a thorough classification of parallel program types (konown as "Dwarfs" in teh literature), to provide benchmarks to evaluate the platform design options.

8.2.3. Investissements d'Avenir

8.2.3.1. DEPARTS
Participants: Liliana Cucu-Grosjean, Adriana Gogonel, Codé Lo, Cristian Maxim.

This project is funded by the BGLE Call (*Briques Logicielles pour le Logiciel Embarqué*) of the national support programme *Investissements d'Avenir*. Formally started on October 1st, 2012 with the kick-off meeting held on April, 2013 for administrative reasons. Research will target solutions for probabilistic component-based models, and a Ph.D. thesis should start at latest on September 2015. The goal is to unify in a common framework probabilistic scheduling techniques with compositional assume/guarantee contracts that have different levels of criticality.

8.2.3.2. CLARITY
Participants: Yann Bondue, Julien Deantoni, Robert de Simone, Marie Agnès Peraldi-Frati.

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It was started in September 2014 , and a kick-of meeting was held on October 9th. Partners are: Thales (several divisions), Airbus, Areva, Altran, All4Tec, Artal, the Eclipse Fondation, Scilab Enterprises, CESAMES, U. Rennes, and Inria. The purpose of teh project is to develop and promote an open-source version of the ARCADIA Melody system design environment from Thales, renamed CAPPELLA for that purpose.

8.2.3.3. Capacites
Participants: Liliana Cucu-Grosjean, Dumitru Potop-Butucaru, Yves Sorel, Walid Talaboulma.

This project is funded by the LEOC Call (*Logiciel Embarqué et Objets Connectés*) of the national support programme *Investissements d'Avenir*. It has started on November 1st, 2014 with the kick-off meeting held on November, 12th 2014. The project cordinator is Kalray, and teh objective of the project is to stydy relevance of Kalray-style MPPA processor array for real-time computation in the avionic domain (with partners such as Airbus for instance).

8.3. European Initiatives

8.3.1. Collaborations in European Programs, except FP7 & H2020

8.3.1.1. ARTEMIS PRESTO

Participants: Frédéric Mallet, Arda Goknil, Julien Deantoni, Marie Agnès Peraldi Frati, Robert de Simone, Jean-Vivien Millo.

Type: ARTEMIS

Project title: PRESTO

Duration: April 2011 - March 2014

Coordinator: Miltech (Greece)

Others partners: TELETEL S.A. (Greece), THALES Communications (France), Rapita Systems Ltd. (United Kingdom), VTT (Finland), Softeam (France), THALES (Italy), MetaCase (Finland), Inria (France), University of LâAquila (Italy), MILTECH HELLAS S.A (Greece), PragmaDev (France), Prismtech (United Kingdom), Sarokal Solutions (Finland).

See also: http://www.cesarproject.eu/

Abstract: The PRESTO project aims at improving test-based embedded systems development and validation, while considering the constraints of industrial development processes. This project is based on the integration of test traces exploitation, along with platform models and design space exploration techniques. Such traces are obtained by execution of test patterns, during the software integration design phase, meant to validate system requirements. The expected result of the project is to establish functional and performance analysis and platform optimisation at early stage of the design development. The approach of PRESTO is to model the software/hardware allocation, by the use of modelling frameworks, such as the UML profile for model-driven development of Real Time and Embedded Systems (MARTE). The analysis tools, among them timing analysis including Worst Case Execution Time (WCET) analysis, scheduling analysis and possibly more abstract system-level timing analysis techniques will receive as inputs on the one hand information from the performance modelling of the HW/SW-platform, and on the other hand behavioural information of the software design from tests results of the integration test execution.

8.4. International Initiatives

8.4.1. Inria International Labs

8.4.1.1. HADES LIAMA project

This joint project is held in collaboration with ECNU Shanghai, together with the Scale Inria team, and extends in scope the Associated Team DAESD (see below). As part of this project Frédéric Mallet spends a sabbatical year at ECNU Shanghai, partly funded by an Inria delegation programme.
We attended a number of LIAMA meetings, both in France and in Beijing, most often in confcall form.

8.4.2. Inria Associate Teams

8.4.2.1. DAESD

Title: Distributed/Asynchronous and Embedded/synchronous Systems Development

Inria principal investigator: Robert de Simone (Aoste) / Eric Madelaine (Scale)

International Partner (Institution - Laboratory - Researcher):

East China Normal University (China) - SEI-Shone - Robert De Simone

Duration: 2012 - 2014

See also: https://team.inria.fr/DAESD/

The development of concurrent and parallel systems has traditionally been clearly split in two different families: distributed and asynchronous systems on one hand, now growing very fast with the recent progress of the Internet towards large scale services and clouds; embedded, reactive, or hybrid systems on the other hand, mostly of synchronous behaviour. The frontier between these families has attracted less attention, but recent trends, e.g. in industrial systems, in Cyber-Physical systems (CPS), or in the emerging Internet of Things, give a new importance to research combining them.

The aim of the DAESD associate team is to combine the expertise of the Oasis and Aoste teams at Inria, the SEI-Shone team at ECNU-Shanghai, and to build models, methods, and prototype software tools inheriting from synchronous and asynchronous models. We plan to address modelling formalisms and tools, for this combined model; to establish a method to analyze temporal and spatial consistency of embedded distributed real-time systems; to develop scheduling strategies for multiple tasks in embedded and distributed systems with mixed constraints.

A dedicated Summer School was organized this year in Shanghai (July 8-11), with participation of Julien Deantoni and Frédéric Mallet from Aoste.

DAESD is strongly linked with the LIAMA project HADES, that it supports.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

8.5.1.1. Invited Professor

Qingguo XU

Date: July 2014 to June 2015

Institution: Shanghai University (China)

8.5.2. Visits to International Teams

8.5.2.1. Sabbatical programme

Mallet Frédéric

Date: Sep 2014 - Aug 2015

Institution: ECNU (China)

<p style="text-align:center">**CASCADE Project-Team**</p>

6. Partnerships and Cooperations

6.1. National Initiatives with Industrials

- **ANR ARPEGE PRINCE: Proven Resilience against Information leakage in Cryptographic Engineering.**
  Participants: Michel Ferreira Abdalla, Sonia Belaid, Fabrice Ben Hamouda, Alain Passelègue, David Pointcheval.

  From December 2010 to May 2015.
  Partners: UVSQ, Oberthur Technologies, Ingenico, Gemalto, Tranef.
  We aim to undertake research in the field of leakage-resilient cryptography with a practical point of view. Our goal is to design efficient leakage-resilient cryptographic algorithms and invent new countermeasures for non-leakage-resilient cryptographic standards. These outcomes shall realize a provable level of security against side-channel attacks and come with a formally verified implementation. For this every practical aspect of the secure implementation of cryptographic schemes must be taken into account, ranging from the high-level security protocols to the cryptographic algorithms and from these algorithms to their implementation on specific devices which hardware design may feature different leakage models.

- **ANR INS SIMPATIC: SIM and PAiring Theory for Information and Communications security.**
  Participants: Angelo de Caro, Houda Ferradi, David Pointcheval, Olivier Sanders, Damien Vergnaud.

  From February 2013 to July 2016.
  Partners: Orange Labs,INVIA, Oberthur Technologies, STMicroelectronics, Université Bordeaux 1, Université de Caen Basse-Normandie, Université de Paris VIII
  We aim at providing the most possible efficient and secure hardware/software implementation of a bilinear pairing in a SIM card.

- **FUI CryptoComp.**
  Participants: Rafael Del Pino, Vadim Lyubashevsky.

  From October 2014 to September 2017.
  Partners: CEA, UVSQ, CryptoExperts, Dictao, XLIM, ViAccess Orca, CNRS, Bertin Technologies, KalRay, Gemalto
  We aim at studying delegation of computations to the cloud, in a secure way.

6.2. National Collaborations within Academics

- **ANR JCJC ROMAnTIC: Randomness in Mathematical Cryptography.**
  Participants: Thierry Mefenza, David Pointcheval, Sylvain Ruhault, Adrian Thillard, Damien Vergnaud.

  From October 2012 to September 2016.
  Partners: ANSSI, Univ. Paris 7, Univ. Paris 8.
  The goal of this project is to get a better understanding of the interplay between randomness and cryptography and to study the security of various cryptographic protocols at different levels (information-theoretic and computational security, number-theoretic assumptions, design and provable security of new and existing constructions).

- **ANR JCJC CLE: Cryptography from Learning with Errors.**
  Participants: Vadim Lyubashevsky, Pierrick Méaux, Thomas Prest.

  From October 2013 to September 2017.
  Partners: UVSQ, Univ. Paris 8, Inria/SECRET.
  The main objective of this project is to explore the potential practical implications of the Learning with Errors problem and its variants. The plan is to focus on the constructions of essential primitives whose use is prevalent in the real world. Toward the end of the project, the hope is to propose and standardize several public key and symmetric key schemes that have specific advantages over ones that are currently deployed.

- **ANR JCJC EnBiD: Encryption for Big Data.**
  Participant: Hoeteck Wee.

  From October 2014 to September 2018.
  Partners: Univ. Paris 2, Univ. Paris 8.
  The main objective of this project is to study techniques for efficient and expressive functional encryption schemes. Functional encryption is a novel paradigm for public-key encryption that enables both fine-grained access control and selective computation on encrypted data, as is necessary to protect big, complex data in the cloud.

6.3. European Initiatives

- **SecFuNet: Security for Future Networks.**
  Participants: Michel Ferreira Abdalla, Vadim Lyubashevsky, David Pointcheval.

  From July 2011 to April 2014.
  The goal of the SECFUNET project is to design and develop a coherent security architecture for virtual networks and cloud accesses.

- **ICT COST CryptoAction: Cryptography for Secure Digital Interaction**
  Participant: Vadim Lyubashevsky.

  From April 2014 to April 2018.
  The aim of this COST Action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

- **ERC CryptoCloud: Cryptography for the Cloud.**
  Participants: Michel Ferreira Abdalla, Florian Bourse, Fabrice Ben Hamouda, Geoffroy Couteau, Thomas Peters, David Pointcheval, Hoeteck Wee.

  From June 2014 to May 2019.

6.4. Other Grants

- **Google: Google Research Award.**
  Participant: Hoeteck Wee.

  On the security of TLS. The goal of this project is to initiate a formal cryptographic treatment of new mechanisms and proposals for reducing the latency in the TLS Handshake Protocol and to enhance our cryptographic understanding of the TLS Handshake Protocol.

6.5. International Research Visitors

- Hugo Krawczyk (IBM)
- Serdar Pehlivanoğlu (Zirve University, Turkey)
- Kai-Min Chung (Academia Sinicia, Taiwan)

- Daniel Wichs (Northeastern)
- Mehdi Tibouchi (NTT)
- Vinod Vaikuntanathan (MIT)
- Kenny Paterson (RHUL)
- Tal Malkin (Columbia)
- David Cash (Rutgers)
- Igor Shparlinski
- Zvika Brakerski (Weizmann)
- Elette Boyle (Technion)
- Giuseppe Persiano (Salerno)
- Yuval Ishai (Technion)
- Eike Kiltz (RUB)

<p style="text-align:center;color:red;font-weight:bold;">CRYPT Team</p>

5. Partnerships and Cooperations

5.1. National Initiatives

5.1.1. MOST's 973 Grant

Grant   2013CB834205

PIs   Phong Nguyen and Xiaoyun Wang

Duration   2013-17

MOST is China's Ministry of Science and Technology.

5.1.2. NSFC Grant

Grant   NSFC Key Project 61133013

PIs   Phong Nguyen and Xiaoyun Wang

Duration   2013-16

NSFC is the National Natural Science Foundation of China.

5.2. European Initiatives

5.2.1. Collaborations with Major European Organizations

CWI: Cryptography team of Ronald Cramer (Netherlands) organisme 1, labo 1 (pays 1) This team is officially a partner of LIAMA's CRYPT international project.

5.3. International Initiatives

5.3.1. Inria International Labs

- CRYPT is an international project from LIAMA in China, hosted by Tsinghua University in Beijing. It is a joint project between Inria, Tsinghua University, CAS Academy of Mathematics and System Sciences, and CWI (Netherlands).
- Phong Nguyen is the European director of LIAMA.

5.3.2. Inria International Partners

5.3.2.1. Informal International Partners

- Univ. Oklahoma, USA
- Univ. Wisconsin, USA

5.4. International Research Visitors

5.4.1. Visits of International Scientists

Cheng Qi   (Univ. Oklahoma, USA)

Mehdi Tibouchi   (NTT, Japan)

Guangwu Xu   (Univ. Wisconsin, USA)

DEDUCTEAM Exploratory Action

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Locali

We are coordinators of the ANR-NFSC contract Locali with the Chinese Academy of Sciences.

7.1.2. ANR BWare

We are members of the ANR *BWare*, which started on September 2012 (David Delahaye is the national leader of this project). The aim of this project is to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the *B* method. The methodology used in this project consists in building a generic platform of verification relying on different theorem provers, such as first order provers and SMT solvers. We are in particular involved in the introduction of Deduction modulo in the first order theorem provers of the project, i.e. *Zenon* and *iProver*, as well as in the backend for these provers with the use of *Dedukti*.

The ANR mid-term review of the project took place in October 2014 and the members of the project received very positive feedbacks from the reviewers. A more detailed report is expected from the reviewers in early 2015.

7.1.3. ANR Tarmac

We are members of the ANR Tarmac on models of computation, coordinated by Pierre Valarcher.

7.2. International Research Visitors

7.2.1. Visits to International Teams

7.2.1.1. Research stays abroad

Olivier Hermant was an invited researcher at the Natal University (UFRN, Brazil) in December 2014.

GALLIUM Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR projects

8.1.1.1. BWare
Participants: Damien Doligez, Fabrice Le Fessant.

The "BWare" project (2012-2016) is coordinated by David Delahaye at Conservatoire National des Arts et Métiers and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. BWare is an industrial research project that aims to provide a mechanized framework to support the automated verification of proof obligations coming from the development of industrial applications using the B method and requiring high guarantees of confidence.

8.1.1.2. Paral-ITP
Participant: Damien Doligez.

The "Paral-ITP" project (2011-2014) is coordinated by Burkhart Wolff at Université Paris Sud and funded by the *Ingénierie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. The objective of Paral-ITP is to investigate the parallelization of interactive theorem provers such as Coq and Isabelle.

8.1.1.3. Verasco
Participants: Jacques-Henri Jourdan, Xavier Leroy.

The "Verasco" project (2012-2015) is coordinated by Xavier Leroy and funded by the *Ingéniérie Numérique et Sécurité* programme of *Agence Nationale de la Recherche*. The objective of this 4-year project is to develop and formally verify a static analyzer based on abstract interpretation, and interface it with the CompCert C verified compiler.

8.1.2. FSN projects

8.1.2.1. ADN4SE
Participants: Damien Doligez, Jael Kriener.

The "ADN4SE" project (2012-2016) is coordinated by the Sherpa Engineering company and funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The aim of this project is to develop a process and a set of tools to support the rapid development of embedded software with strong safety constraints. Gallium is involved in this project to provide tools and help for the formal verification in TLA+ of some important aspects of the PharOS real-time kernel, on which the whole project is based.

8.1.2.2. CEEC
Participants: Thomas Braibant, Maxime Dénès, Xavier Leroy.

The "CEEC" project (2011-2014) is coordinated by the Prove & Run company and also involves Esterel Technologies and Trusted Labs. It is funded by the *Briques Génériques du Logiciel Embarqué* programme of *Fonds national pour la Société Numérique*. The CEEC project develops an environment for the development and certification of high-security software, centered on a new domain-specific language designed by Prove & Run. Our involvement in this project focuses on the formal verification of a C code generator for this domain-specific language, and its interface with the CompCert C verified compiler.

8.1.3. FUI projects

8.1.3.1. Richelieu

Participants: Michael Laporte, Fabrice Le Fessant.

The "Richelieu" project (2012-2014) is funded by the *Fonds unique interministériel* (FUI). It involves Scilab Enterprises, U. Pierre et Marie Curie, Dassault Aviation, ArcelorMittal, CNES, Silkan, OCamlPro, and Inria. The objective of the project is to improve the performance of scientific programming languages such as Scilab's through the use of VMKit and LLVM.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. DEEPSEA

> Type: FP7
>
> Defi: NC
>
> Instrument: ERC Starting Grant
>
> Objectif: NC
>
> Duration: June 2013 - May 2018
>
> Coordinator: Umut Acar
>
> Partner: Inria
>
> Inria contact: Umut Acar
>
> Abstract: the objective of project DEEPSEA is to develop abstractions, algorithms and languages for parallelism and dynamic parallelism, with applications to problems on large data sets.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

- Princeton University: interactions between the CompCert verified C compiler and the Verified Software Toolchain developed at Princeton.
- Cambridge University and Microsoft Research Cambridge: formal modeling and testing of weak memory models.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Sigurd Schneider, Ph.D. student at Saarlandes University in Saarbrucken, visited Gallium from Mar 2014 to May 2014. As part of his Ph.D., Sigurd Schneider develops an intermediate representation that unifies static single assignment form (SSA) and functional intermediate representations. During his internship, he considered the addition of GC support to this intermediate representation. He also developed a program logic to verify the correctness of a class of optimizations, including constant subexpression elimination (CSE) and global value numbering.

8.4.1.2. Research stays abroad

Since November 2014, Damien Doligez is on a sabbatical at Jane Street (New York, USA), a financial company (member of the Caml Consortium) that invests considerable R&D in the OCaml language and system.

MUTANT Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. INEDIT

Title: Interactivity in the Authoring of Time and Interactions

Project acronym: INEDIT

Type: ANR Contenu et Interaction 2012 (CONTINT)

Instrument: ANR Grant

Duration: September 2012 - September 2015

Coordinator: IRCAM (France)

Other partners: Grame (Lyon, France), LaBRI (Bordeaux, France).

Abstract: The INEDIT project aims to provide a scientific view of the interoperability between common tools for music and audio productions, in order to open new creative dimensions coupling *authoring of time* and *authoring of interaction*. This coupling allows the development of novel dimensions in interacting with new media. Our approach lies within a formal language paradigm: An interactive piece can be seen as a virtual interpreter articulating locally synchronous temporal flows (audio signals) within globally asynchronous event sequence (discrete timed actions in interactive composition). Process evaluation is then to respond reactively to signals and events from an environment with heterogeneous actions coordinated in time and space by the interpreter. This coordination is specified by the composer who should be able to express and visualize time constraints and complex interactive scenarios between mediums. To achieve this, the project focuses on the development of novel technologies: dedicated multimedia schedulers, runtime compilation, innovative visualization and tangible interfaces based on augmented paper, allowing the specification and realtime control of authored processes. Among posed scientific challenges within the INEDIT project is the formalization of temporal relations within a musical context, and in particular the development of a GALS (Globally Asynchronous, Locally Synchronous) approach to computing that would bridge in the gap between synchronous and asynchronous constraints with multiple scales of time, a common challenge to existing multimedia frameworks.

7.1.2. Other National Initiatives

Jean-Louis Giavitto participates in the SynBioTIC ANR Blanc project (with IBISC, University of Evry, LAC University of Paris-Est, ISC - Ecole Polytechnique).

The team is also an active member of the ANR network CHRONOS (investigator Gérard Berry, Collège de France).

7.2. European Initiatives

7.2.1. Collaborations in European Programs, except FP7 & H2020

Mutant has started a cooperation with the team of Christoph Kirsch at the University of Salzburg, Austria, around the application of the application of the Logical Execution Time realtime programming paradigm to computer music systems supporting advanced temporal structure in music and advanced dynamics in interactivity. We have settled a project LETITBE accepted in the program PHC Amadeus, and to be started in january 2015.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- Shlomo Dubnov (UCSD)
- Edward Lee (UC Berkeley)
- Miller Puckette (UCSD)
- Masahiko Sakai (U. Nagoya)
- Slawek Staworko (U. Edinburgh)
- David Wessel (UC Berkeley)

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Masahiko Sakai (Professor at the University of Nagoya) visited MuTant for two weeks in April and October 2014, For collaborations on term rewriting techniques applied to the representations of rhythm in music notations.

Slawek Staworko (LINKS, on leave at U. of Edinburgh) visited MuTant for two weeks in June and July 2014, for collaborations on the problem of automatic rhythm transcriptions.

7.4.2. Visits to International Teams

MuTant team members Arshia Cont, Jean-Louis Giavitto and José Echeveste made a formal visit to M.I.T. MediaLab in May 2014 to showcase MuTant work and discuss further collaborations with several New Media teams at MIT.

7.4.2.1. Research stays abroad

José Echeveste stays during six weeks in several Universities of United States which enables collaborations with the following teams and centers:

- Center for Hybrid and Embedded Software Systems (UC Berkeley)
- The Center for New Music and Audio Technologies (UC Berkeley)
- Center for Computer Research in Music and Acoustics (Stanford)
- Roger Dannenberg's team (Carnegie Mellon University)
- Computer Music Center (Columbia University)

This trip allows to share research experience with many people with different areas of expertise and to broadly disseminate the Mutant team work in the main computer music centers and other important computer research centers of United States.

José Echeveste (MuTant PhD students) undertook a Research Stay in UC Berkeley's EECS department, Center for Hybrid and Embedded Software Systems (CHESS) for two months between April and May 2014. His visit was highlighted by several master classes and workshops on MuTant research in diverse institutions such as UC Berkeley, Columbia University and MIT.

<p style="text-align:center; color:red;">**PARKAS Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

ANR WMC project (program "jeunes chercheuses, jeunes chercheurs"), 2012–2016, 200 Keuros. F. Zappa Nardelli is the main investigator.

ANR Boole project (program "action blanche"), 2009-2014.

ANR CAFEIN, 2013-2015. Marc Pouzet.

7.1.2. Investissements d'avenir

Sys2Soft contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Dassault-Systèmes, etc. Inria contacts are Benoit Caillaud (HYCOMES, Rennes) and Marc Pouzet (PARKAS, Paris).

ManycoreLabs contract (Briques Génériques du Logiciel Embarqué). Partenaire principal: Kalray. Inria contacts are Albert Cohen (PARKAS, Paris), Alain Darte (COMPSYS, Lyon), Fabrice Rastello (CORSE, Grenoble).

7.1.3. Others

Marc Pouzet is scientific advisor for the Esterel-Technologies/ANSYS company.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. COPCAMS

       Type: ARTEMIS JU

       Defi: NC

       Instrument: ASP

       Objectif: NC

       Duration: April 2013 - March 2016

       Coordinator: Christian Fabre

       Partner: CEA LETI, Grenoble, France

       Inria contact: Albert Cohen

       Abstract: Cognitive cameras on manycore platforms

7.2.1.2. EMC2

       Type: ARTEMIS JU

       Defi: NC

       Instrument: AIPP

       Objectif: NC

       Duration: April 2014 - March 2917

       Coordinator: Werner Weber

       Partner: Infineon, Munich ,Germany

       Inria contact: Albert Cohen

Abstract: Embedded multicrical systems on multicores

7.2.1.3. ITEA2

Type: ITEA2

Defi: NC

Instrument: NC

Objectif: NC

Duration: September 2012 - November 2015

Coordinator: Daniel Bouskela (EDF)

Partner: Dassault-Systèmes, EDF, Modelon, DLR (Germany)

Inria contact: Benoit Caillaud, Marc Pouzet

Abstract: Model Driven Physical Systems Operation

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. POLYFLOW

Title: Polyhedral Compilation for Data-Flow Programming Languages

International Partner (Institution - Laboratory - Researcher):

IISc Bangalore (INDE)

Duration: 2013 - 2015/12

See also: http://polyflow.gforge.inria.fr

Polyhedral techniques for program transformation are now used in several proprietary and open source compilers. However, most of the research on polyhedral compilation has focused on imperative languages such as C, where computation is specified in terms of statements with zero or more nested loops and other control structures around them. Graphical data-flow languages, where there is no notion of statements or a schedule specifying their relative execution order, have so far not been studied using a powerful transformation or optimization approach. These languages are extremely popular in system analysis, modeling and design, in embedded reactive control. They also underline the construction of many domain-specific languages and compiler intermediate representations. The copy and execution semantics of data-flow languages impose a different set of challenges. We plan to bridge this gap by studying techniques that could enable extraction of a polyhedral representation from data-flow programs, transform them, and synthesize them from their equivalent polyhedral representation.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Prof. Cesare Tinelli, was invited by ENS in the PARKAS team.

Date: June 2014 (one month)

Institution: Iowa State University, USA.

7.4.1.1. Internships

Siddharth Prusty Siddharth

Date: May 2014 - Jul 2014

Institution: IITK (India)

Vijay Keswani Vijay

Date: May 2014 - Jul 2014

Institution: IITK (India)

Quentin Bunel

Date: May 2014 - Jul 2014

Institution: UPMC (France)

Abhishek Jain

Date: May 2014 - Jul 2014 and Dec 2014 - Jan 2015

Institution: IITD (India)

Yabin Hu

Date: Jun 2014 - Jul 2014

Institution: China Nat. Univ. of Defense and Technology (China)

<div align="center" style="color:red">**PI.R2 Project-Team**</div>

6. Partnerships and Cooperations

6.1. National Initiatives

Alexis Saurin (coordinator) and Yann Régis-Gianas are members of the four-year RAPIDO ANR project accepted in 2014 and starting in January 2015. RAPIDO aims at investigating the use of proof-theoretical methods to reason and program on infinite data objects. The goal of the project is to develop logical systems capturing infinite proofs (proof systems with least and greatest fixed points as well as infinitary proof systems), to design and to study programming languages for manipulating infinite data such as streams both from a syntactical and semantical point of view. Moreover, the ambition of the project is to apply the fundamental results obtained from the proof-theoretical investigations (i) to the development of software tools dedicated to the reasoning about programs computing on infinite data, *e.g.* stream programs (more generally coinductive programs), and (ii) to the study of properties of automata on infinite words and trees from a proof-theoretical perspective with an eye towards model-checking problems. Other permanent members of the project are Christine Tasson from PPS, David Baedle from LSV, ENS-Cachan, and Pierre Clairambault, Damien Pous and Colin Riba from LIP, ENS-Lyon.

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the three-years Focal project of the IDEX Sorbonne Paris Cité, started in June 2013. This project, giving the support for the PhD grant of Cyrille Chenavier, concerns the interactions between higher-dimensional rewriting and combinatorial algebra. This project is with members of the LAGA (Laboratory of Mathematics, Univ. Paris 13).

Pierre-Louis Curien (coordinator), Yves Guiraud and Philippe Malbos are members of the four-years Cathre ANR project, started in January 2014. This project investigates the general theory of higher-dimensional rewriting, the development of a general-purpose library for higher-dimensional rewriting, and applications in the fields of combinatorial algebra, combinatorial group theory and theoretical computer science.

Matthieu Sozeau, Hugo Herbelin, Lourdes del Carmen González Huesca and Yann Régis-Gianas are members of the ANR Paral-ITP started in November 2011. Paral-ITP is about preparing the Coq and Isabelle interactive theorem provers to a new generation of user interfaces thanks to massive parallelism and incremental type-checking.

Hugo Herbelin is the coordinator of the PPS site for the ANR Récré accepted in 2011, which started in January 2012. Récré is about realisability and rewriting, with applications to proving with side-effects and concurrency.

Matthieu Sozeau is member of the ANR Typex (Types and certification for XML) and is coordinator of one of the tasks of the project on formalisation and certification of XML tools. The project kicked-off in January 2012 and is a joint project with LRI, PPS and Inria Grenoble.

Yann Régis-Gianas collaborates with Mitsubishi Rennes on the topic of differential semantics. This collaboration led to the CIFRE grant for the PhD of Thibaut Girka.

Matthieu Sozeau is a member of the CoqHoTT project led by Nicolas Tabareau (Ascola team, École des Mines de Nantes), funded by an ERC Starting Grant.

6.2. European Initiatives

6.2.1. *Collaborations with Major European Organisations*

Pierre-Louis Curien, Yves Guiraud and Philippe Malbos are collaborators of the Applied and Computational Algebraic Topology (ACAT) networking programme of the European Science Foundation.

6.3. International Initiatives

6.3.1. Inria International Partners

The project-team has collaborations with Wroclaw University (Poland), University of Aarhus (Denmark), University of Oregon, University of Tokyo, University of Sovi Sad, University of Nottingham, Institute of Advanced Study, MIT and University of Cambridge.

6.3.2. Participation In other International Programs

Pierre-Louis Curien participates to the ANR International French-Chinese project LOCALI (coordinated by Gilles Dowek), and to a MathAmSud project in algebraic operads with the university of Talca (Chile).

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Beta Ziliani (MPI Saarbrücken) visited πr^2 for one week in November 2014 to collaborate with Yann Régis-Gianas and Matthieu Sozeau.

Peter Aczel (Manchester Univ.), Steve Awodey (Carnegie Mellon University), Thierry Coquand (Univ. Göteborg), and Vladimir Voevodsky (Institute for Advanced Study) were Inria funded invited professors for the thematic IHP trimester Semantics of Proofs and Certified Mathemtatics.

6.4.1.1. Internships

Akira Yoshimizu is an international Inria intern, working on abstract machines for quantum programmming languages inspired from game semantics and linear logic.

6.4.2. Visits to International Teams

6.4.2.1. Research stays abroad

Pierre-Louis Curien visited Chili (Univ. of Talca) in March 2014 (collaborative work with Maria Ronco in operad theory).

<p style="text-align:center; color:red">**POLSYS Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

- **ANR Grant (international program) EXACTA (2010-2013): Exact/Certified Algorithms with Algebraic Systems.**
  The main objective of this project is to study and compute the solutions of nonlinear algebraic systems and their structures and properties with selected target applications using exact or certified computation. The project consists of one main task of basic research on the design and implementation of fundamental algorithms and four tasks of applied research on computational geometry, algebraic cryptanalysis, global optimization, and algebraic biology. It will last for three years (2010-2013) with 300 person-months of workforce. Its consortium is composed of strong research teams from France and China (KLMM, SKLOIS, and LMIB) in the area of solving algebraic systems with applications.

- **ANR Grant HPAC: High Performance Algebraic Computing (2012-2016).** The pervasive ubiquity of parallel architectures and memory hierarchy has led to a new quest for parallel mathematical algorithms and software capable of exploiting the various levels of parallelism: from hardware acceleration technologies (multi-core and multi-processor system on chip, GPGPU, FPGA) to cluster and global computing platforms. For giving a greater scope to symbolic and algebraic computing, beyond the optimization of the application itself, the effective use of a large number of resources (memory and specialized computing units) is expected to enhance the performance multi-criteria objectives: time, resource usage, reliability, even energy consumption. The design and the implementation of mathematical algorithms with provable, adaptive and sustainable performance is a major challenge. In this context, this project is devoted to fundamental and practical research specifically in exact linear algebra and system solving that are two essential "dwarfs" (or "killer kernels") in scientific and algebraic computing. The project should lead to progress in matrix algorithms and challenge solving in cryptology, and should provide new insights into high performance programming and library design problems (J.-C. Faugère [contact], L. Perret, G. Renault, M. Safey El Din).

- **ANR Grant GeoLMI: Geometry of Linear Matrix Inequalities (2011-2015).** GeoLMI project aims at developing an algebraic and geometric study of linear matrix inequalities (LMI) for systems control theory. It is an interdisciplinary project at the border between information sciences (systems control), pure mathematics (algebraic geometry) and applied mathematics (optimisation). The project focuses on the geometry of determinantal varieties, on decision problems involving positive polynomials, on computational algorithms for algebraic geometry, on computational algorithms for semi-definite programming, and on applications of algebraic geometry techniques in systems control theory, namely for robust control of linear systems and polynomial optimal control (Participants: J.-C. Faugère, M. Safey El Din [contact], E. Tsigaridas).

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. A3

Type: PEOPLE

Defi:

Instrument: Career Integration Grant

Objectif: NC

Duration: May 2013 - April 2017

Coordinator: Jean-Charles Faugère

Partner: Institut National de Recherche en Informatique et en Automatique (Inria), France

Inria contact: Elias Tsigaridas

Abstract: The project Algebraic Algorithms and Applications (A3) is an interdisciplinary and multidisciplinary project, with strong international synergy. It consists of four work packages The first (Algebraic Algorithms) focuses on fundamental problems of computational (real) algebraic geometry: effective zero bounds, that is estimations for the minimum distance of the roots of a polynomial system from zero, algorithms for solving polynomials and polynomial systems, derivation of non-asymptotic bounds for basic algorithms of real algebraic geometry and application of polynomial system solving techniques in optimization. We propose a novel approach that exploits structure and symmetry, combinatorial properties of high dimensional polytopes and tools from mathematical physics. Despite the great potential of the modern tools from algebraic algorithms, their use requires a combined effort to transfer this technology to specific problems. In the second package (Stochastic Games) we aim to derive optimal algorithms for computing the values of stochastic games, using techniques from real algebraic geometry, and to introduce a whole new arsenal of algebraic tools to computational game theory. The third work package (Non-linear Computational Geometry), we focus on exact computations with implicitly defined plane and space curves. These are challenging problems that commonly arise in geometric modeling and computer aided design, but they also have applications in polynomial optimization. The final work package (Efficient Implementations) describes our plans for complete, robust and efficient implementations of algebraic algorithms.

7.3. International Initiatives

7.3.1. Inria International Labs

We are involved in the ECCA (Exact/Certifed Computation with Algebraic Systems) Team of LIAMA. Our partners are mainly from the Chinese Academy of Sciences and Beihang Univ. Our research focuses mainly on polynomial system solving and its applications.

7.3.2. Inria Associate Teams

7.3.2.1. QOLAPS

Title: Hybrid Methodologies for Quantifier Elimination, Global Optimization, Linear Algebra and Polynomial System Solving

International Partner (Institution - Laboratory - Researcher):

North Carolina State University (ÉTATS-UNIS)

Duration: 2012 - 2014

See also: http://www-polsys.lip6.fr/QOLAPS/index.html

Reliable and certified computing is a major issue in computer science motivated by huge needs in engineering sciences and in the industry (aeronautics, railway transports, etc.). At the same time, the need for high-performance computational routines is constantly increasing. It is tackled on the one hand by designing asymptotically fast algorithms which often have the feature to be randomized and/or approximate and/or probabilistic and on the other hand by developing high performance implementations. Our goal is to conciliate high-performance computing with certification and/or validation issues. We will mainly focus on algebraic problems, and precisely on linear and non-linear systems of equations and/or inequalities. In this context, hybrid methodologies combining exact and numeric computation are traditionally used in two separate ways: either exact computation is used to analyze the robustness of numerical schemes or numerical computation is used to speed up computations. Our viewpoint is to mix these trends in hybrid methodologies by exploiting the scientific continuum from linear algebra to quantifier elimination and global optimization through Grobner bases computations for polynomial system solving.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Éric Schost, Univ. Western Ontario, Canada.

Nitin Saxena, IIT Kanpur, India.

Danilo Gligoroski, NTNU, Norway.

7.4.1.1. Internships

Ivan Bannwarth

> Date: Mar 2014 – Aug 2014
>
> Institution: Université de Versailles – Saint-Quentin-en-Yvelines (France)

Matías Bender

> Date: Sep 2014 – Feb 2015
>
> Institution: Universidad de Buenos Aires (Argentine)

Anca Nitulescu

> Date: Mar 2014 – Aug 2014
>
> Institution: Université Paris Diderot (France)

Ulrick Severin

> Date: Sep 2013 – Mar 2014
>
> Institution: Dassault Systèmes (France)

PROSECCO Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ProSe

> Title: ProSe: Security protocols : formal model, computational model, and implementations (ANR VERSO 2010.)

> Other partners: Inria/Cascade, ENS Cachan-Inria/Secsi, LORIA-Inria/Cassis, Verimag.

> Duration: December 2010 - December 2014.

> Coordinator: Bruno Blanchet, Inria (France)

> Abstract: The goal of the project is to increase the confidence in security protocols, and in order to reach this goal, provide security proofs at three levels: the symbolic level, in which messages are terms; the computational level, in which messages are bitstrings; the implementation level: the program itself.

7.1.1.2. AJACS

> Title: AJACS: Analyses of JavaScript Applications: Certification and Security

> Other partners: Inria-Rennes/Celtique, Inria-Saclay/Toccata, Inria-Sophia Antipolis/INDES, Imperial College London

> Duration: October 2014 - March 2019.

> Coordinator: Alan Schmitt, Inria (France)

> Abstract: The goal of the AJACS project is to provide strong security and privacy guarantees for web application scripts. To this end, we propose to define a mechanized semantics of the full JavaScript language, the most widely used language for the Web, to develop and prove correct analyses for JavaScript programs, and to design and certify security and privacy enforcement mechanisms.

7.1.2. FUI

7.1.2.1. Pisco

> Title: PISCO

> Partners: Bull, Cassadian, CEA, CS, Saferiver, Serpikom, Telecom Paristech

> Duration: January 2013 - December 2014.

> Coordinator: Liliana Calabanti, Bull (France)

> Abstract: The goal of the project is to develop a prototype of a new secure applicance based on a virtual machine architecture accessing an HSM. The role of PROSECCO is to contribute to the analysis of security http://www.systematic-paris-region.org/en/projets/pisco

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. CRYSP

> Type: FP7

> Defi: NC

> Instrument: ERC Starting Grant

Objectif: NC

Duration: November 2010 - October 2015

Coordinator: Karthikeyan Bhargavan

Partner: Inria (France)

Inria contact: Valérie Boutheon

Abstract: The goal of this grant is to develop a collaborative specification framework and to build incremental, modular, scalable verification techniques that enable a group of collaborating programmers to build an application and its security proof side-by-side. We propose to validate this framework by developing the first large-scale web application and full-featured cryptographic protocol libraries with formal proofs of security.

7.3. International Initiatives

7.3.1. Inria International Partners

7.3.1.1. Informal International Partners

- Microsoft Research (Cambridge, Redmond): Joint research and development on F*, miTLS, and JavaScript with Cedric Fournet, Markulf Kohlweiss, and Nikhil Swamy
- University of Pennsylvania, Portland State University, Harvard University: Joint research on Micro-Policies: Formally Verified Low-Level Tagging Schemes for Safety and Security
- Imperial College (London): Joint research on web application security with Sergio Maffeis
- University of Venice Ca'Foscari: Joint research on security APIs

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Nikhil Swamy, Limin Jia, Benjamin Pierce, Cedric Fournet visited our group and gave seminars.
- Matteo Maffei, Dominique Unruh, Gilles Barthe, François Dupressoir, came to teach at the Joint EasyCrypt-F*-CryptoVerif School.

7.4.1.1. Internships

Cairns Kelsey

> Date: Mar 2014 - May 2014
>
> Institution: Washington State University (USA)

Paraskevopoulou Zoi

> Date: Apr 2014 - Sep 2014
>
> Institution: National Technical University of Athens (Greece)

Giannarakis Nikolaos

> Date: Apr 2014 - Sep 2014
>
> Institution: National Technical University of Athens (Greece)

Azevedo De Amorim, Arthur

> Date: Mar 2014 - Aug 2014
>
> Institution: University of Pennsylvania (USA)

Jindal Shubham

> Date: May 2014 - Jul 2014
>
> Institution: Indian Institute of Technology Delhi (India)

Thomson Susan

> Date: Jun 2014 - Aug 2014
>
> Institution: University of Bristol (UK)

<p style="text-align:center">**SECRET Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- **ANR BLOC** ($10/11 \rightarrow 09/15$)
  Design and Analysis of block ciphers dedicated to constrained environments
  ANR program: Ingénierie numérique et sécurité
  Partners: INSA Lyon, Inria (project-team SECRET), University of Limoges (XLIM), CryptoExperts
  446 kEuros
  http://bloc.project.citi-lab.fr
  The BLOC project aims at providing strong theoretical and practical results in the domain of cryptanalysis and design of block ciphers.

- **ANR KISS** ($12/11 \rightarrow 12/15$)
  Keep your personal Information Safe and Secure
  ANR program: Ingénierie numérique et sécurité
  Partners: Inria (project-teams SMIS and SECRET), LIRIS, Gemalto, University of Versailles-St Quentin, Conseil Général des Yvelines
  64 kEuros
  The KISS project builds upon the emergence of new portable and secure devices known as Secure Portable Tokens (e.g., mass storage SIM cards, secure USB sticks, smart sensors) combining the security of smart cards and the storage capacity of NAND Flash chips. The idea promoted in KISS is to embed, in such devices, software components capable of acquiring, storing and managing securely personal data.

- **ANR CLE** ($10/13 \rightarrow 10/17$)
  Cryptography from learning with errors
  ANR program: Jeunes Chercheurs, SIMI2
  Coordinator: Vadim Lyubashevsky (Inria, project-team Cascade)
  The aim of this project is to combine algorithmic and algebraic techniques coming from asymmetric and symmetric cryptology in order to improve some attacks and to design some symmetric primitives which have a good resistance to side-channel attacks.

- **ANR BRUTUS** ($10/14 \rightarrow 09/18$)
  Authenticated Ciphers and Resistance against Side-Channel Attacks
  ANR program: Défi Société de l'information et de la communication
  Partners: ANSSI, Inria (project-team SECRET and project-team MARELLE), Orange, University of Lille, University of Rennes, University Versailles-Saint Quentin
  160 kEuros
  The Brutus project aims at investigating the security of authenticated encryption systems. We plan to evaluate carefully the security of the most promising candidates to the Caesar competition, by trying to attack the underlying primitives or to build security proofs of modes of operation. We target the traditional black-box setting, but also more "hostile" environments, including the hardware platforms where some side-channel information is available.

8.1.2. Others

- **French Ministry of Defense** ($10/12 \rightarrow 09/15$)
  Funding for the supervision of Audrey Tixier's PhD.
  30 kEuros.

- **PEPS IQC 2013** (04/13 → 03/14)
  Topology and quantum codes
  coordinated by G. Zémor, Institut de Mathématiques de Bordeaux.
  http://www.cnrs.fr/mi/spip.php?article301
- **PEPS IQC 2013** (04/13 → 03/14)
  Quantum Cryptography and distributed computing
  coordinated by Frédéric Grosshans, Laboratoire Aimé Cotton.
  http://www.cnrs.fr/mi/spip.php?article301

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: COST

Project acronym: ICT COST Action IC1306

Project title: Cryptography for Secure Digital Interaction

Duration: January 2014 - November 2017

Coordinator: Claudio Orlandi, Aarhus University, Denmark

Other partners: see http://www.cost.eu/domains_actions/ict/Actions/IC1306

Abstract: The aim of this COST action is to stimulate interaction between the different national efforts in order to develop new cryptographic solutions and to evaluate the security of deployed algorithms with applications to the secure digital interactions between citizens, companies and governments.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

Title: Discrete Mathematics, Codes and Cryptography

International Partner (Institution): Indian Statistical Institute, Kolkata (India)

Duration: 2014

This collaboration investigates the three following topics: Quantum information and cryptography; Design and maintenance of primitives for symmetric cryptography; Low-cost cryptography designs from coding theory and combinatorics.

8.3.1.2. Informal International Partners

- Otto-von-Guericke Universität Magdeburg, Institut für Algebra und Geometrie (Germany): Study of Boolean functions for cryptographic applications
- Nanyang Technological University (Singapore): cryptanalysis of symmetric primitives.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Dimitrios Simos, SBA Research, Vienna, Austria, February 9-15, 2014;
- Marco Tomamichel, University of Sydney, Sydney, Australia, September 30-October 9, 2014;
- Markku-Juhani O. Saarinen, Norwegian University of Science and Technology, Norway, November 8-30, 2014;
- Céline Blondeau, Aalto University, Finland, November 12-13, 2014.

8.4.2. Internships

- Kaushik Chakraborty, ISI Kolkata (India), May 15-June 15, 2014
- Sébastien Duval, Telecom ParisTech, July-December 2014
- Adrien Hauteville, Univ. Limoges, March-August 2014

8.4.3. Visits to International Teams

- Simons Institute for the Theory of Computing, Berkeley, California, February - March, *Quantum Hamiltonian Complexity Program*: A. Chailloux and A. Leverrier;
- Université Catholique de Louvain-la-Neuve, Belgium, visiting Franòis-Xavier Standaert, March 10-11: G. Leurent;
- UAB, Barcelona, Spain, visiting Andreas Winter, October 26 - November 4: A. Chailloux;
- Nanyang Technological University, Singapore, visiting Thomas Peyrin, May 19-June 6: G. Leurent.

TEMPO Team

7. Partnerships and Cooperations

7.1. International Initiatives

7.1.1. Inria International Labs

The TEMPO project belongs to the LIAMA laboratory in China. The project is hosted by East China Normal University Software Engineering Institute.

7.1.2. Inria International Partners

7.1.2.1. Declared Inria International Partners

The projects is run in collaboration with East China Normal University Software Engineering Institute and Netherlands CWI.

7.1.3. Participation In other International Programs

The project is run within the context of China LIAMA laboratory.

CLASSIC Project-Team

5. Partnerships and Cooperations

5.1. National Initiatives

ANR project in the blank program: Calibration (2012–2015; involves Vincent Rivoirard, who is the coordinator; see https://sites.google.com/site/anrcalibration/home)

GAMMA3 Project-Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. ANR

F. Alauzet, N. Barral, V. Menier and A. Loseille are part of the MAIDESC ANR (2013-2015) on mesh adaptation for moving interfaces in CFD.

6.2. European Initiatives

6.2.1. FP7 & H2020 Projects

P. Laug participates in the GEOPRISM (GEOlogical resources PRotection and exploitation using Innovative Simulation Methods - Towards new generations of simulation technologies) project, submitted to H2020-FETOPEN-2014-2015-RIA. This project involves several Inria teams (Sage, Gamma3, Pomdapi, Coffee) and several European research centers and universities.

6.3. International Initiatives

6.3.1. Inria Associate Teams

6.3.1.1. AM2NS

Title: Advanced Meshing Methods for Numerical Simulations

International Partner (Institution - Laboratory - Researcher):

Mississippi State University (ÉTATS-UNIS)

Duration: 2014 - 2016

See also: https://www.rocq.inria.fr/gamma/gamma/Membres/CIPD/Frederic.Alauzet/AssociateTeam_AM2NS/AT_am2ns.html

Numerical simulation is now mature and has become an integral part of design in science and engineering applications. Meshing, i.e., discretizing the computational domain, is at the core of the computational pipeline and a key element to significant improvements. The AM2NS Associate Team focus on developing the next generation of automated meshing methods to improve their robustness and the mesh quality to solve the ever increasing complexity of numerical simulations. Four major meshing issues are targeted: (i) more robustness for mesh generation methods in recovering a given data set, (ii) higher quality for anisotropic adapted meshes via constraint alignment, (iii) higher quality for boundary layer meshes near geometry singularities, and (iv) more robustness in handling complex displacement for moving mesh methods. The impact of this collaborative research will be to provide more reliable solution output predictions in an automated manner by using these new meshing methods.

6.4. International Research Visitors

6.4.1. Visits to International Teams

6.4.1.1. Sabbatical programme

Laug Patrick

Date: Sep 2014 - Aug 2015

Institution: Polytechnique Montréal (Canada)

The main scientific objectives are twofold: the reconstruction of a 3D space or scene from multiple images, and the parallelization of the mesh generation of multiface models on multicore processors.

<div align="center">

MATHERIALS Team

</div>

7. Partnerships and Cooperations

7.1. National Initiatives

The team is involved in several ANR projects:

- the ANR MANIF focuses on the mathematical and numerical analysis of electronic structure models, such as, in particular, the Kohn-Sham model. It includes two research teams: researchers from the JL Lions Laboratory (Paris 6) and the MATHERIALS team. It is coordinated by E. Cancès.
- E. Cancès is involved in the ANR BECASIM, which is concerned with the numerical simulation of Bose-Einstein condensates. This ANR has been accepted in June 2012, and is coordinated by I. Danaila (Université de Rouen).
- C. Le Bris participates to the ANR EMAQS. The scientist in charge is Karine Beauchard.
- T. Lelièvre is member of the ANR-project "STAB" (PI: I. Gentil, Université de Lyon).
- The team also benefited from a NEEDS interdisciplinary funding from CNRS on numerical methods for the simulation of defects in materials

In addition, the team is participating in

- the GdR Quantum dynamics. This interdisciplinary research network is focused on physical and mathematical problems related to the time evolution of quantum systems (transport problems, nonequilibrium systems, etc),
- the GdR Shocks,
- the GdR Maths et entreprise,
- the GdR correl (correlated methods in electronic structure computations),
- the GdR CoDFT (electronic structure computations using density functional theory).

The MATHERIALS team project is involved in two Labex, namely the Labex Bezout (started in 2011) and the Labex MMCD (started in 2012).

7.2. European Initiatives

The ERC consolidator Grant MSMATH (ERC Grant Agreement number 614492, PI T. Lelièvre) has started in June 2014.

7.3. International Initiatives

T. Lelièvre, G. Stoltz and F. Legoll participate to the Laboratoire International Associé (LIA) CNRS / University of Illinois at Urbana-Champaign on complex biological systems and their simulation by high performance computers. This LIA involves on the French side research teams from Université de Nancy, Université de Lyon and Inria Rennes.

7.4. International Research Visitors

7.4.1. *Visits of International Scientists*

J. Weare (University of Chicago) has been invited for a one month stay (February-March 2014) with the support of the Labex Bezout.

7.4.2. *Visits to International Teams*

F. Legoll, T. Lelièvre and G. Stoltz have visited the group of K. Schulten (Urbana-Champaign) on January 27-30, 2014

<div align="center">**MATHRISK Project-Team**</div>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

B. Jourdain is involved in the ANR Stab (2013/2016). Partners: Lyon1 and Paris-Dauphine.

8.1.2. Competitivity Clusters

Pôle Finance Innovation.

8.2. International Initiatives

8.2.1. Inria International Partners

8.2.1.1. Informal International Partners

- Center of Excellence program in Mathematics and Life Sciences at the Department of Mathematics, University of Oslo, Norway, (B. Øksendal).
- Department of Mathematics, University of Manchester (Tusheng Zhang, currently in charge of an EU-ITN program on BSDEs and Applications).
- Mannheim University (Alexander Schied, Chair of Mathematics in Business and Economics, Department of Mathematics)
- Roma Tor Vergata University (Lucia Caramellino)
- Ritsumeikan University (A. Kohatsu-Higa).

8.3. International Research Visitors

8.3.1. Visits of International Scientists

- Arturo Kohatsu-Higa, Ritsumeikan University, 3 months

- Lucia Caramellino, Tor Vergata University, Roma, 2 weeks

- Oleg Kudryavtsev, Rostov University , 2 months

- Xiao Wei, Beijing university, 2 months

8.3.2. Visits to International Teams

8.3.2.1. Research stays abroad

- V. Bally, Ritsumeikan University, Japan, one month
- A. Sulem:

  - "Adjunct Professorship", Center of Mathematics for Applications (CMA), University of Oslo, Norway, 1st Semester 2014.

  - Participation to the "Stochastics in Environmental and Financial Economics" program, Centre of Advanced Studies of the Norwegian Academy of Sciences and Letters, Oslo, Last term 2014.

<p align="center" style="color:red">MOKAPLAN Team</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

Jean-David Benamou is the coordinator of the ANR ISOTACE (Interacting Systems and Optimal Transportation, Applications to Computational Economics) ANR-12-MONU-0013 (2012-2016). The consortium explores new numerical methods in Optimal Transportation AND Mean Field Game theory with applications in Economics and congested crowd motion. Four extended seminars have been organized/co-organized by Mokaplan. Check https://project.inria.fr/isotace/news.

Christophe Duquesne (Aurigetech) is a software and mobility consultant hired on the ANR budget. He helps the consortium to develop its industrial partnerships.

7.2. International Initiatives

7.2.1. Inria Associate Teams

7.2.1.1. MOKALIEN

Title: Numerical Optimal Transportation in (Mathematical) Economics

International Partner (Institution - Laboratory - Researcher):

McGill University (CANADA)

Duration: 2014 - 2016

See also: https://team.inria.fr/mokaplan/mokalien/

The overall scientific goals is to develop numerical methods for large scale optimal transport and models based on optimal transport tools
see https://team.inria.fr/mokaplan/files/2014/09/MOKALIEN_Proposal_2013.pdf, section 2.

A few additional applications were suggested at our annual workshop in october
https://team.inria.fr/mokaplan/first-meeting-in-montreal-at-u-mcgill-october-20-24-2014/

7.3. International Research Visitors

7.3.1. Visits of International Scientists

Adam Oberman (U. Mc Gill) visited Mokaplan in June.

7.3.2. Visits to International Teams

7.3.2.1. Sabbatical programme

Guillaume Carlier in on sabbatical for the academic year (délégation CNRS at the UMI-CNRS 3069 PIMS at UVIC, Victoria, British Columbia, Canada). He is taking advantage of this full-research year to work on optimal transport methods for kinetic models for granular media (with M. Agueh and Reinhard Illner), Wasserstein barycenters and to continue to develop joint projects on numerical optimal transport with J.D. Benamou's MOKAPLAN team.

QUANTIC Team

6. Partnerships and Cooperations

6.1. National Initiatives

6.1.1. *Towards QUANTIC project-team / PSL* structuring project TOCOSUQI*

In the framework of the creation of the QUANTIC project-team, we have continued our going collaboration with the non-Inria members of this future project-team (not yet official members of QUANTIC). Indeed, we have a close collaboration with the experimental physicists Benjamin Huard and Françlis Mallet at ENS and applied mathematician Pierre Rouchon at Mines Paristech. These collaborations include all the subjects introduced in the above research program. In the framework of these collaborations, we have also benefited from a 2-year PSL* funding from september 2013 to August 2015. The funding was, in particular, used for the 6 months visit of Ananda Roy, PhD student at Yale university. The PSL* project TOCOSUQI (Tools of the control of superconducting quantum circuits) aims at developing new system theory tools for preparing, manipulating and protecting non-classical states of a microwave field in the framework of quantum Josephson circuits and circuit quantum electrodynamics, and applying them directly in the experiments.

6.1.2. *ANR project EPOQ2*

This young researchers ANR project, entitled "Estimation problems for quantum and quantum-like systems" and led by Mazyar Mirrahimi, was run between October 2009 and June 2014. This project had contributed to the development of a system theory approach in quantum engineering, with applications, in particular, within the field of quantum information processing. After important and fruitful collaborations with the physicists at Laboratoire Kastler-Brossel, ENS, our activities turned towards the feedback control of quantum systems taking into account the destructive character of quantum measurements. This later on led to new collaborations with the Physicists at Yale university which will be detailed in the sequel. EPOQ2 was highlighted in the 2013 annual report of Agence Nationale de la Recherche.

6.1.3. *ANR project GEARED*

This three-year collaborative ANR project, entitled "Reservoir engineering quantum entanglement in the microwave domain" and coordinated by Mazyar Mirrahimi, started on October 2014. The participants of the project are Daniel Esteve and Fabien Portier (Quantronics group, CEA Saclay), François Mallet and Benjamin Huard (Laboratoire Pierre Aigrain, ENS), Nicolas Roch and Olivier Buisson (Institut Neel, Grenoble) and Mazyar Mirrahimi (Inria). This project deals with robust generation of entanglement as a key resource for quantum information processing (quantum simulation, computation and communication). The entangled states are difficult to generate and sustain as interaction with a noisy environment leads to rapid loss of their unique quantum properties. Through Geared we intend to investigate different complementary approaches to master the entanglement of microwave photons coupled to quantum superconducting circuits.

6.2. European Initiatives

6.2.1. *Collaborations with Major European Organizations*

Partner 1: University of Padova

Alain Sarlette has been pursued a fruitful collaboration with the group of Francesco Ticozzi on "dynamical systems aspects of quantum systems": besides concluding their work on "symmetrization and quantum consensus", mainly initiated before A.S. joined Inria, a novel line of work in the direction of quantum thermalization and quantum random walks has been explored. Further joint work for the future is planned about among others generalized Markovian feedback and weak reservoir engineering.

Partner 2: Ghent University.

A. Sarlette is establishing a collaboration with applied mathematicians interested in quantum control at UGent (Dirk Aeyels and Lode Wylleman) in the framework of thesis co-supervisions. One PhD student is co-supervised with Dirk Aeyels in the framework of Belgian Inter-University Attraction Poles "Dynamical Systems, Control and Optimization" network 2013-2017. A second PhD student is also co-supervised with Dirk Aeyels in the framework of Chinese Scholarship Council and Flanders Research Fund grant "Developing control mechanisms to counter biases and drifts in coordination", 2013-2015. Finally, benefiting from a UGent starting grant on "Coordination control algorithms inspired from nonlinear PDEs and lattices", 2013-2017, Alain Sarlette also supervises a third PhD student at Ghent University.

6.3. International Initiatives

6.3.1. Inria International Partners

6.3.1.1. Declared Inria International Partners

The collaborations with the teams of Michel H. Devoret, Robert J. Schoelkopf, Liang Jiang and Steven M. Girvin, enforced through a two year sabbatical visit of Mazyar Mirrahimi at Yale university, have led to a set of contributions ranging from the theoretical analysis and performance optimization of ongoing experiments on weak quantum measurements [2] and preparation of non-classical field states through single photon Kerr effect [3] to the design of new experiments on single qubit cooling [1] and stabilization of maximally entangled states of superconducting qubits [8] by reservoir engineering techniques. Through these collaborations, Mazyar Mirrahimi and his former PhD student, Zaki Leghtas, currently a postdoc with Michel H. Devoret's group, have introduced a new direction for hardware-efficient universal quantum computation [4], [5]. These theoretical proposals have already led to groundbreaking experiments [10], [9].

6.4. International Research Visitors

6.4.1. Visits of International Scientists

Ananda Roy, Yale university, Department of Applied Physics, PhD student from the groups of A. Douglas Stone and Michel H. Devoret, has visited us for sixth month from February through July 2014.

6.4.2. Visits to International Teams

6.4.2.1. Research stays abroad

Mazyar Mirrahimi spent four months in the Quantronics Laboratory of Michel H. Devoret and in the Rob Schoelkopf Lab at Yale University.

<p style="text-align:center">**SIERRA Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR: Calibration

Participant: Sylvain Arlot.

Titre: Statistical calibration

Coordinator: University Paris Dauphine

Leader: Vincent Rivoirard

Other members: 34 members, mostly among CEREMADE (Paris Dauphine), Laboratoire Jean-Alexandre Dieudonné (Université de Nice) and Laboratoire de Mathématiques de l'Université Paris Sud

Instrument: ANR Blanc

Duration: Jan 2012 - Dec 2015

Total funding: 240 000 euros

Webpage: https://sites.google.com/site/anrcalibration/

7.1.2. CNRS: Gargantua

Participants: Sylvain Arlot, Francis Bach, Simon Lacoste-Julien, Alexandre d'Aspremont.

Titre: Big data; apprentissage automatique et optimisation mathématique pour les données gigantesques

Coordinator: Laboratoire Jean Kuntzmann (UMR 5224)

Leader: Zaid Harchaoui

Other members: 13 members: S. Arlot, F. Bach, S. Lacoste-Julien, A. d'Aspremont and researchers from Laboratoire Jean Kuntzmann, Laboratoire d'Informatique de Grenoble (Universite Joseph Fourier) and Laboratoire Paul Painleve (Universite Lille 1).

Instrument: défi MASTODONS du CNRS

Duration: May 2013-Dec 2014

Total funding: 60 000 euros for the two years

Webpage: http://lear.inrialpes.fr/people/harchaoui/projects/gargantua/index.html

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. SIERRA

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Duration: December 2009 - November 2014

Coordinator: F. Bach

Abstract: Machine learning is now a core part of many research domains, where the abundance of data has forced researchers to rely on automated processing of information. The main current paradigm of application of machine learning techniques consists in two sequential stages: in the representation phase, practitioners first build a large set of features and potential responses for model building or prediction. Then, in the learning phase, off-the-shelf algorithms are used to solve the appropriate data processing tasks. While this has led to significant advances in many domains, the potential of machine learning techniques is far from being reached.

7.2.1.2. SIPA

Type: FP7

Defi: NC

Instrument: ERC Starting Grant

Objectif: NC

Duration: May 2011 - May 2016

Coordinator: A. d'Aspremont (CNRS)

Abstract: Interior point algorithms and a dramatic growth in computing power have revolutionized optimization in the last two decades. Highly nonlinear problems which were previously thought intractable are now routinely solved at reasonable scales. Semidefinite programs (i.e. linear programs on the cone of positive semidefinite matrices) are a perfect example of this trend: reasonably large, highly nonlinear but convex eigenvalue optimization problems are now solved efficiently by reliable numerical packages. This in turn means that a wide array of new applications for semidefinite programming have been discovered, mimicking the early development of linear programming. To cite only a few examples, semidefinite programs have been used to solve collaborative filtering problems (e.g. make personalized movie recommendations), approximate the solution of combinatorial programs, optimize the mixing rate of Markov chains over networks, infer dependence patterns from multivariate time series or produce optimal kernels in classification problems. These new applications also come with radically different algorithmic requirements. While interior point methods solve relatively small problems with a high precision, most recent applications of semidefinite programming in statistical learning for example form very large-scale problems with comparatively low precision targets, programs for which current algorithms cannot form even a single iteration. This proposal seeks to break this limit on problem size by deriving reliable first-order algorithms for solving large-scale semidefinite programs with a significantly lower cost per iteration, using for example subsampling techniques to considerably reduce the cost of forming gradients. Beyond these algorithmic challenges, the proposed research will focus heavily on applications of convex programming to statistical learning and signal processing theory where optimization and duality results quantify the statistical performance of coding or variable selection algorithms for example. Finally, another central goal of this work will be to produce efficient, customized algorithms for some key problems arising in machine learning and statistics.

7.2.1.3. SpaRTaN

Type: FP7

Defi: NC

Instrument: Initial Training Network

Duration: October 2014 to October 2018

Coordinator: Mark Plumbley (University of Surrey)

Inria contact: Francis Bach

Abstract: The SpaRTaN Initial Training Network will train a new generation of interdisciplinary researchers in sparse representations and compressed sensing, contributing to Europe's leading role in scientific innovation.

By bringing together leading academic and industry groups with expertise in sparse representations, compressed sensing, machine learning and optimisation, and with an interest in applications such as hyperspectral imaging, audio signal processing and video analytics, this project will create an interdisciplinary, trans-national and inter-sectorial training network to enhance mobility and training of researchers in this area.

SpaRTaN is funded under the FP7-PEOPLE-2013-ITN call and is part of the Marie Curie Actions — Initial Training Networks (ITN) funding scheme: Project number - 607290

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. STATWEB

Title: Fast Statistical Analysis of Web Data via Sparse Learning

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2011 - 2014

See also: http://www.di.ens.fr/~fbach/statweb.html

The goal of the proposed research is to provide web-based tools for the analysis and visualization of large corpora of text documents, with a focus on databases of news articles. We intend to use advanced algorithms, drawing from recent progresses in machine learning and statistics, to allow a user to quickly produce a short summary and associated timeline showing how a certain topic is described in news media. We are also interested in unsupervised learning techniques that allow a user to understand the difference between several different news sources, topics or documents.

7.3.2. Inria International Partners

7.3.2.1. International Partners

IFCAM: Collaboration with Indian Institute of Science, Bangalore (Chiranjib Battacharya). 10000 Euros for visits from/to India.

7.4. International Research Visitors

7.4.1. Internships

Visit from Raman Sankaran Indian Institute of Science, Bangalore, May-Juky 2014.

<p style="text-align:center">**ANGE Project-Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

8.1.1. *Instabilities in Hydrodynamics (2011–2015)*
Participant: Nicolas Seguin.

The Emergence project (Ville de Paris and FSMP) "Instabilities in Hydrodynamics" is related to theoretical, applied, and numerical mathematics for the study of hydrodynamical turbulence phenomena.

8.1.2. *Plasticity of geophysical flows and seismic emissions (2013–2016)*
Participant: Anne Mangeney.

This project is funded by Sorbonne Paris Cité (80.000 euros) and is a collaboration between IPGP and Univ. Paris 13.

8.1.3. *LRC Manon (2010–2014 and 2014–2018)*
Participants: Edwige Godlewski, Yohan Penel, Nicolas Seguin.

CEA and Laboratory Jacques-Louis Lions launched a collaboration in order to carry out studies about complex fluids (modelling, numerical simulations and optimisation), in particular about compressible two-phase flows. This includes the derivation of strategies for model coupling, for instance in the case of an asymptotic hierarchy of models. This collaboration was recently renewed for another 4-year partnership.

8.2. National Initiatives

8.2.1. *ANR MIMOSA (2014–2017)*
Participants: Nora Aïssiouene, Marie-Odile Bristeau, Anne Mangeney, Jacques Sainte-Marie.

> Program: ANR Défi 1 "Gestion sobre des ressources et adaptation au changement climatique"
> Project acronym: MIMOSA
> Project title: Microseism MOdeling and Seismic Applications
> Coordinator: Eleonore Stutzmann (IPGP)

Seismic noise is recorded by broadband seismometers in the absence of earthquakes. It is generated by the atmosphere-ocean system with different mechanisms in the different frequency bands. Even though some mechanisms have been known for decades, an integrated understanding of the noise in the broadband period band 1-300sec is still missing. Using novel theoretical, numerical and signal processing methods, this project will provide a unified understanding of the noise sources and quantitative models for broadband noise. Conversely, we will be able to interpret seismic noise in terms of ocean wave properties. This first analysis step will lead to the identification and characterization of source events, which we will use to improve noise tomography, and seismic monitoring.

8.2.2. *ANR LANDQUAKES (2012–2016)*
> Program: ANR Blanc "Mathématiques et interactions"
> Project acronym: LANDQUAKES
> Project title: Modélisation des glissements de terrain et des ondes sismiques générées pour détecter et comprendre les instabilités gravitaires
> Coordinator: Anne Mangeney

Within the ANR domain "Mathematics and Interfaces", this ANR project (between Univ. Paris-Est – LAMA, Univ. Denis Diderot Paris 7 – IPGP, Univ. Nantes – LPGN, Univ. Strasbourg EOST, 180.000 euros) deals with the mathematical and numerical modelling of landslides and generated seismic waves.

A. Mangeney is also involved in the CARIB ANR program (2014–2017) entitled "Comprendre les processus de construction et de destruction des volcans de l'Arc des Petites Antilles".

8.2.3. GdR EGRIN (2013–2017)

Participants: Anne Mangeney, Jacques Sainte-Marie.

EGRIN stands for Gravity-driven flows and natural hazards. J. Sainte-Marie is the head of the scientific committee of this CNRS research group and A. Mangeney is a member of the committee. The scientific goals of this project are the modelling, analysis and simulation of complex fluids by means of reduced-complexity models in the framework of geophysical flows.

8.2.4. ADT Inlgae, Inria Project Lab "Algae in Silico"

Participants: Marie-Odile Bristeau, Raouf Hamouda, Jacques Sainte-Marie.

In the framework of the ADT Inlgae (2013–2014), we developed in collaboration with the BIOCORE Inria project-team a simulation tool for microalgae culture. It lead to the recruitment of R. Hamouda as a young engineer.

An Inria Project Lab "Algae in Silico" is planned in collaboration with BIOCORE. It concerns microalgae culture for biofuel production and the aim is to provide an integrated platform for numerical simulation "from genes to industrial processes".

8.2.5. ANR project HJnet (2013–2015)

Participant: Edwige Godlewski.

This research project consists in studying Hamilton-Jacobi equations on networks, and more generally on heterogeneous structures. This theoretical problem has several potential applications, in particular to traffic flow theory.

8.2.6. Statistical Inference for Structure Health Monitoring (I4S)

Participant: Nicolas Seguin.

The I4S team results from a collaboration between Ifsttar and Inria. N. Seguin is funded by this team. His work consists in providing efficient numerical tools to take into account the impact of the flows around the structures. The most challenging part of this project concerns the off-shore wind turbines and the understanding of the ice formation on the structure.

8.2.7. Hydraulics for environment and sustainable development (HED[2])

The scienfitic group (GIS in French), which includes Inria, brings together scientists and engineers involved in hydraulics, risk management and sustainable development. ANGE belongs to this group. On the one hand, the team can be provided with experimental measurements (erosion, long waves, fluid structure interactions,...) thanks to this collaboration; on the other hand, the GIS can favor the transfer of numerical tools and scientific results.

8.3. European Initiatives

8.3.1. ERC Consolidator Grant (2013–2018)

Participant: Anne Mangeney.

The project SLIDEQUAKES about detection and understanding of landslides by observing and modelling gravitational flows and generated earthquakes has been funded by the European Research Council (2.000.000 euros).

8.4. International Initiatives

8.4.1. Inria International Partners

8.4.1.1. Informal International Partners

The team has developed strong relations with researchers from Spanish universities, in particular with Carlos Pares (Malaga), Enrique Fernandez-Nieto and Tomas Chacon Rebollo (Sevilla). They have an expertise in complex flows, including variable density flows, erosion, non-hydrostatic effects, ...

<p align="center" style="color:red">ARAMIS Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR HM-TC

Participants: Olivier Colliot [Correspondant], Marie Chupin, Didier Dormont, Denis Schwartz, Dominique Hasboun, Linda Marrakchi-Kacem, Claire Cury.

Project acronym: HM-TC

Project title: Model of the hippocampo-cortical connectivity in "temporal consciousness" in normal and pathological memory derived from multimodal anatomical and functional brain imaging (aMRI, DT-MRI, MEG, fMRI)

Duration: Nov 2009- Nov 2014

Amount: 2M€

Coordinator: Olivier Colliot (ARAMIS) and Gianfranco Dalla Barba

Other partners: CENIR, ENS Cachan, Neurospin, Grenoble Institut des Neurosciences

Abstract: The aim of this project is to evaluate the role of the medial temporal lobe and its connections with various cortical regions in temporal consciousness related tasks and to derive a neuro-computational model of memory processing from multimodal imaging data. Temporal consciousness is defined as the ability to specify one's own time-location with respect to past, present and future, and is thus a more general framework than episodic memory. Based on an original cognitive model and relying on memory dysfunctions called confabulations, different groups of participants (controls, patients with Alzheimer's disease, patients with several memory disorders) will be evaluated through cognitive tests, MEG, anatomical, functional and diffusion-tensor MRI. New signal and image processing methods will be developed for all these modalities, in order to describe in a more robust and precise way both the anatomy and the function of the medial temporal lobe. First, using in vivo ultra high field MRI acquisitions (7 Tesla), we will build a precise anatomical atlas of the hippocampus and its inner structure. This model will allow designing efficient MEG source reconstruction in these regions, and new methods to analyse anatomical and functional connectivity. Using the most recent mathematical achievements in the theory of diffeomorphic deformations, we will propose new registration and morphometry methods in order to analyze very precisely the structural alterations of the medial temporal lobe. These new methods will be applied to the neuroimaging data acquired for the project in order to analyse extensively the relationships between memory disorders and structural and functional brain alterations revealed by neuroimaging.

8.1.1.2. ANR PREV-DEMALS

Participants: Olivier Colliot [Correspondant], Marie Chupin, Stanley Durrleman, Anne Bertrand.

Project acronym: PREV-DEMALS

Project title: Predict to prevent frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS)

Duration: Avr 2015 - Avr 2019

Amount: 487k€

Coordinator: Isabelle Le Ber

Other partners: ICM, AP-HP, CHR de Lille, CHU Limoges, CHU Rouen, Laboratory of Biomedical Imaging

Abstract: The project focuses on C9ORF72, the most frequent genetic form of frontotemporal lobar degeneration (FTLD) and amyotrophic lateral sclerosis (ALS). Since 2006, major discoveries have helped elucidate the pathological bases and linked FTLD and ALS: 1) TDP-43 aggregates in neurons and 2) C9ORF72 mutations in both disorders. Two major pathological subtypes are now defined in FTLD, FTLD-TDP and FTLD-TAU. C9ORF72 mutations (associated to FTLD-TDP) are the most frequent genetic causes of FTLD (15%), FTLD-ALS (65%) and ALS (40%). No curative treatment actually exists, but therapeutics emerged against tau aggregation. The objectives of the project are to develop appropriate cognitive, brain imaging markers and peripheral biomarkers of the early phase of FTLD, to follow disease progression and to guide future targeted therapeutic trials. To address this questions, we will conduct a multimodal study (cognition, brain structural MRI, brain metabolism - FDG-PET) in C9ORF72 families. The cohort will be followed at 3-time points (M0, M18, M36). Longitudinal analyses will aim at characterizing the trajectory of decline across time. Brain structural changes will be evaluated by 1) morphometric analysis to assess global brain atrophy, cortical thickness and study of the cortical sulci; 2) functional connectivity analysis of resting-state MR data; 3) structural connectivity analysis of diffusion-weighted MRI. Brain metabolism will be evaluated with FDG-PET. We will use the most recent RNA sequencing technology to detect gene expression and RNA splicing alterations in lymphocytes of patients and presymptomatic carriers. The discovery of new markers involved in FTLD will have practical consequences for early and accurate diagnosis of FLD and ALS disease.

8.1.2. IHU

8.1.2.1. General program

Participants: Olivier Colliot, Mario Chavez, Stanley Durrleman, Marie Chupin, Didier Dormont, Dominique Hasboun, Damien Galanaud, Fabrizio de Vico Fallani.

Project acronym: IHU-A-ICM

Project title: Institute of Translational Neuroscience

Founded in 2011

General Director: Bertrand Fontaine

The IHU-A-ICM program was selected, in 2011, in a highly competitive national call for projects. A 10-year, 55M€ program, has been implemented by a recently created foundation for scientific cooperation. Based on the clinical and scientific strenghts of the ICM and the hospital Department of Nervous System Diseases, it mainly supports neuroscience research, but is also invested in improving care and teaching. ARAMIS is strongly involved in the IHU-A-ICM project, in particular in WP6 (neuroimaging and electrophysiology), WP7 (biostatistics), WP2 (Alzheimer) and WP5 (epilepsy). We have started collaborations with the new bioinformatics/biostatistics platform (IHU WP7, head: Ivan Moszer), in particular through a joint project on the integration of imaging and genomics data.

8.1.2.2. Internal Research projects

Participants: Mario Chavez, Fabrizio de Vico Fallani.

Project title: Non-invasive manipulation of brain synchrony to enhance brain function and rehabilitate faulty cognition in humans: A proof of concept

Founded in 2014

Coordinator: Antoni Valero Cabre

The long-term goal of this project is to develop the use of non-invasive manipulation of abnormal cerebral oscillations underlying cognitive activity to restore brain function in neurological patients. Cognitive functions emerge from large distributed networks organized in space and time. The short-term goal of this application is to study the causal role played by oscillatory activity in visual awareness and test whether their manipulation by non-invasive brain stimulation has the potential to restore its function in stroke patients.

8.1.3. CATI (Alzheimer Plan)

Participants: Olivier Colliot [Correspondant], Marie Chupin [Correspondant], Stanley Durrleman, Didier Dormont, Chabha Azouani, Ali Bouyahia, Johanne Germain, Xavier Badé, Sonia Djobeir, Hugo Dary, Ludovic Fillon, Takoua Kaaouana, Alexandre Routier, Sophie Lecomte, Mathieu Dubois.

Project acronym: CATI

Project title: Centre d'Acquisition et de Traitement des Images

Founded in 2011

Amount: 9M€

Coordinator: Jean-François Mangin

Other partners: Neurospin, CENIR, Inserm U678, IM2A

Abstract: The CATI project (funded by the National Alzheimer Plan for 9M€, 2.1M€ for ARAMIS) aims at creating a national platform for multicenter neuroimaging studies. CATI aims to be a national resource for the scientific, medical and industrial research community and will provide a wide range of services: access to a national acquisition network, standardization of acquisitions, image quality control, image analysis, databasing/archiving, meta-analyses. Through CATI, our team coordinates a large network composed of over 30 image acquisition centers. CATI already supports over 15 multicenter projects including the national cohort MEMENTO (2300 subjects). CATI is integrated with France Life Imaging (PI: F. Lethimonnier) and the Neugrid for you (N4U, PI: G. Frisoni) network.

8.1.4. National Networks

- GdR Statistics and Medicine - http://gdr.statsante.fr/Accueil.html

8.1.5. Other National Programs

8.1.5.1. Programme Hospitalier de Recherche Clinique (PHRC)
Participants: Olivier Colliot, Marie Chupin, Stanley Durrleman, Didier Dormont, Damien Galanaud.

- PHRC PredictPGRN, co-funding by Alzheimer Plan, *Caractérisation multimodale prospective de la démence frontotemporale dûe à des mutations du gène PGRN à un stade symptomatique et présymptomatique*. (Coordinator : A. Brice)

- PHRC ImaBio3, co-funding by Roche (pharmaceutical industry), *Rôle des réactions cellulaires sanguines, inflammatoires et immunitaires anti-amyloïde centrales et périphériques dans la maladie d'Alzheimer débutante*. (Coordinator : M. Sarazin)

- PHRC CAPP, *Caractérisation linguistique, anatomique/métabolique et biologique des différentes formes d'aphasie primaire progressive : vers le rationnel pour des essais pharmacologiques et des rééducations du langage ciblées*. (Coordinator: M. Teichmann)

8.1.5.2. Institut Universitaire d'Ingénierie pour la Santé (IUIS)
Participants: Mario Chavez, Xavier Navarro.

Project acronym: DYSPEV

Project title: Dépistage de la dyspnée par potentiels évoqués visuels

Founded in 2014

Amount: 38K€

Coordinator: Thomas Similowski

Other partners: UPMC, Inserm UMR 1158

Abstract: Steady state visual evoked potentials (SSVEP) have been widely utilized in brain computer interfacing (BCI) in last years. In this project, we explore the possibilities of SSVEP to manage the communication between patients suffering from respiratory disorders and health care providers. By imposing different breathing constraints, we use a SSVEP-based brain computer interface to help those subjects to communicate their breathing sensations (breathing well/breathing bad).

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Participants: Stefan Thurner, Vito Latora, Albert Diaz-Guilera, Maxi San Miguel, Cecilia Mascolo, Mirco Murolesi, Mario Chavez [Correspondant].

Project acronym: LASAGNE

Project title: multi-LAyer SpAtiotemporal Generalized NEtworks

Founded in 2012

Amount: 1.6M€

Coordinator: Stefan Thurner

Other partners: Medical University of Vienna, Queen Mary University of London, Universitat de Barcelona, Universitat de les Illes Balears,University of Cambridge, University of Birmingham.

Abstract: The aim of the LASAGNE project is to provide a novel and coherent theoretical framework for analyzing and modelling dynamic and multi-layer networks in terms of multi-graphs embedded in space and time. To do this, we will treat time, space and the nature of interactions not as additional dimensions of the problem, but as natural, inherent components of the very same generalized network description. The theory will be validated on real-world applications involving large and heterogeneous data sets of brain networks, on- and off-line social systems, healthcare systems, and transportation flows in cities. The LASAGNE project will provide new quantitative opportunities in different fields, ranging from the prediction of pathologies to the diffusion of ideas and trends in societies, and for the management of socio-technological systems.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Non-contractual International Partners

S. Durrleman has an enduring collaboration with the Scientific Computing and Imaging (SCI) Institute at the University of Utah (USA). He is consultant for NIH Grant "4D shape analysis for modeling spatiotemporal change trajectories in Huntington's Disease "predict-HD". He is part of the PhD committees of J. Fishbaugh and A. Sharma supervised by professor Guido Gerig.

M. Chupin and O. Colliot have an enduring collaboration with the Center for Magnetic Resonance Research, University of Minnesota, USA (P-F Van de Moortele, T. Henry, M. Marjanska, K. Ugurbil) a leading center in 7T MRI.

D. Galanaud has an enduring collaboration with the Massachusetts General Hospital, Harvard University, USA (R. Gupta).

M. Chavez has a collaborations with the Departement of Mathematics, at Queen Mary University of London, UK (Prof. V. Latora); and the Physics Department of the Universitat de Barcelona, Spain (Prof. Albert Diaz-Guilera)

F. De Vico Fallani has a collaboration with the University Sapienza, Rome, Italy (Profs. Fabio and Claudio Babiloni) and with the IRCCS Fondazione Santa Lucia, Rome, Italy (M. Molinari and D. Mattia).

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Research stays abroad

M. Chavez spent 45 days as visiting researcher in the Physics Department of the Universitat de Barcelona, Spain (February, 2014)

CLIME Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

- The ANR project Estimair aims at quantifying the uncertainties of air quality simulations at urban scale. The propagation of uncertainties requires the use of model reduction and emulation. A key uncertainty source lies in the traffic emissions, which will be generated using a dynamic trafic assignment model. Ensembles of traffic assignments will be calibrated and used in the uncertainty quantification. Estimair is led by Clime.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: COST Action ES104.

Project acronym: EuMetChem.

Project title: European framework for online integrated air quality and meteorology modeling.

Duration: January 2011 - December 2014.

Coordinator: Alexander Baklanov, Danish Meteorological Institute (DMI) Danemark.

Other partners: around 14 European laboratories, experts from United States, ECMWF.

Abstract: European framework for online integrated air quality and meteorology modeling (EuMetChem) focuses on a new generation of online integrated Atmospheric Chemical Transport (ACT) and Meteorology (Numerical Weather Prediction and Climate) modeling with two-way interactions between different atmospheric processes including chemistry (both gases and aerosols), clouds, radiation, boundary layer, emissions, meteorology and climate. Two application areas of the integrated modeling are considered: (i) improved numerical weather prediction (NWP) and chemical weather forecasting (CWF) with short-term feedbacks of aerosols and chemistry on meteorological variables, and (ii) two-way interactions between atmospheric pollution/ composition and climate variability/change. The framework consists of four working groups namely: 1) Strategy and framework for online integrated modeling; 2) Interactions, parameterizations and feedback mechanisms; 3) Chemical data assimilation in integrated models; and finally 4) Evaluation, validation, and applications. Establishment of such a European framework (involving also key American experts) enables the EU to develop world class capabilities in integrated ACT/NWP-Climate modeling systems, including research, forecasting and education.

8.2.2. Collaborations with Major European Organizations

Partner: ERCIM working group "Environmental Modeling".

The working group gathers laboratories working on developing models, processing environmental data or data assimilation.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Partner: Chilean meteorological office (Dirección Meteorológica de Chile)

The partner produces its operational air quality forecasts with Polyphemus. The 3-day forecasts essentially cover Santiago. The forecasts are accessible online in the form of maps, time series and video (http://www.meteochile.gob.cl/modeloPOLYPHEMUS.php).

Partner: Marine Hydrophysical Institute http://mhi.nas.gov.ua/en/index.html, Ukraine.

The collaboration concerns the study of the Black Sea surface circulation and the issue of image assimilation in forecasting models.

Partner: IBM Research, Dublin, Ireland

The collaboration addresses the assimilation of classical observations as well as images, with application to geophysics. New assimilation methods are developed, mainly based on minimax filtering.

LIFEWARE Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR Projects

- ANR Blanc Hyclock (2014-2018) on "Hybrid modeling of time for Circadian Clock Biology and Chronopharmacology", coordinated by F. Delaunay (CNRS, Nice), F. Lévi (INSERM Paris-Sud), G. Bernot (CNRS I3S, Nice), O. Roux (Ecle Centrale Nantes).
- ANR Blanc STOCH-MC (2014-2018) on "Stochastic Models: Scalable Model Checking", coordinated by Blaise Genest (Inria Rennes), with Grégory Batt, Wieslaw Zielonka (LIAFA), and Hugo Gimbert (LaBRI).
- ANR Investissement Avenir ICEBERG project (2011-2016) "From population models to model populations", coordinated by Grégory Batt, with Pascal Hersen (MSC lab, Paris Diderot Univ./CNRS), Reiner Veitia (Institut Jacques Monod, Paris Diderot Univ./CNRS), Olivier Gandrillon (BM2A lab, Lyon Univ./CNRS), Cédric Lhoussaine (LIFL/CNRS), and Jean Krivine (PPS lab, Paris Diderot Univ./CNRS).
- ANR Cosinus Syne2arti project (2010-2014) "From synthetic gene networks to artificial tissues" coordinated by Grégory Batt, with Oded Maler (CNRS Verimag), Dirk Drasdo (EPI Mamba), and Ron Weiss (MIT).
- ANR Blanc BIOTEMPO project (2010-2014) coordinated by Anne Siegel (EPI DYLISS), with Ovidiu Radulescu (U. Montpellier), O. Roux (Ecole Centrale de Nantes), Irina Rusu (U. Nantes).
- ANR Blanc NET-WMS-2 (2011-2015) on "constraint optimization in Wharehouse Management Systems", coordinated by F. Fages, with N. Beldiceanu (Ecole des Mines de Nantes, EPI TASC), and Abder Aggoun (KLS optim).

8.1.2. BPI-OSEO BioIntelligence Project

- OSEO-BPI Biointelligence project (2009-2014) coordinated by Dassault-Systèmes, with Sobios, Aureus pharma, Ipsen, Pierre Fabre, Sanofi-Aventis, Servier, Bayer CropScience, INSERM, Genopole Evry, EPI Orpailleur.

8.1.3. GENCI Contract

- GENCI (2009-) attribution of 300000 computation hours per year on the Jade cluster of 10000 cores of GENCI at CINES, Montpellier. Used for hardest parameter search problems in BIOCHAM-parallel.

8.2. International Initiatives

8.2.1. Inria Associate Teams

8.2.1.1. TISHOM

> Title: Artificial tissue homeostasis: combining synthetic and computational biology approaches
> Inria principal investigator: Grégory Batt
> International Partner (Institution - Laboratory - Researcher):
> > Massachusetts Institute of Technology (United States) - Weiss Lab
> Duration: 2012 - 2014

Cell-based gene therapy aims at creating and transplanting genetically-modified cells into a patient in order to treat an illness. Ideally, actively-growing cells are used to form a self-maintaining tissue in the patient, thus permanently curing the disease. Still, before any real therapeutic use, many important issues need to be addressed. In particular, one should guarantee tissue homeostasis, that is, that the size of the newly-introduced tissue remains within admissible bounds. The TISHOM project focused on developing methods and tools to facilitate the design and effective construction of artificial tissues.

In the context of his PhD, Xavier Duportet worked on three projects on engineering human cells. The first one, dealing with developing tools to facilitate the engineering of mammalian cells, has been published [7]. The two others deal with the development of communication systems and still need to be finalized. This experimental work raised a number of more theoretical questions, that were investigated by François Bertaux, together with Szymon Stoma. Two problems have been investigated. The first one dealt with accounting for protein fluctuations for the analysis of signal transduction systems over long time scales and has been published [4]. The second one dealt with the multiscale simulation of tissues and is still under way. During the course of the project, a third line of research emerged, to assist the design of a patterning system currently developed by the Weiss lab. On the computational side, the major issues have been addressed. On the experimental side, additional constructions and characterizations are still needed.

Lastly, the associated team also helped to organize the workshop Design, optimization and control in systems and synthetic biology. Nearly 200 researchers and students attended this event. Although of relatively modest size, this event was attended by a number of leaders of the field and had a significant international visibility.

8.2.2. Inria International Partners

8.2.2.1. Collaboration with National Taiwan University

Since 2012, we have a collaboration with Prof. Jie-Hong Jiang, National Taiwan University first on hybrid simulations of biochemical reaction systems and now on the design of a compiler of digital programs and analog circuits in biochemical reactions. Our preliminary results and common publications on this topic [15], [16] are encouraging but a lot of work is needed to minimize the number of necessary species and reactions. Our aim, in partnership with Franck Molina (CNRS, Sysdiag, Montpellier) is to design a biosensor using our biochemical programming compiler, implement the generated code in a liposome using a microfluidic device, and test its efficacy *in vitro*.

8.3. International Research Visitors

8.3.1. Invited Professors

Prof. Alexander Bockmayr from Freie Universitat, Berlin, Germany, visited us from January to March 2014 for common work on constraint-based methods in computational systems biology, and teaching in our MPRI Master C2.19 course on computational methods for systems and synthetic biology.

<p align="center">**MAMBA Team**</p>

8. Partnerships and Cooperations

8.1. Regional Initiatives

DIGITEO Project (DIM LSC) ALMA

Project title: Mathematical Analysis of Acute Myeloid Leukemia (AML) and its treatments

September 2014 - August 2017

Coordinator: Catherine Bonnet, Disco team, Saclay-IdF

Other partners: Inria Paris-Rocquencourt (Mamba team), France, L2S, France, UPMC (LJLL), St Antoine Hospital, Paris

Abstract: this project follows the regional projects ALMA (2010-2014) and ALMA2 (2011-2013). Starting from the work of J. L. Avila Alonso's PhD thesis in ALMA the aim of this project is to provide a refined coupled model of healthy and cancer cell dynamics in AML whose (stability) analysis will enable evaluation of polychemiotherapies delivered in the case of AML which have a high level of Flt-3 duplication (Flt-3-ITD).

8.2. National Initiatives

8.2.1. ANR

8.2.1.1. ANR 2011-2014 Bimod.

It has been prolonged until 2015, time at which an international workshop in Paris on "Multi-scale and hybrid modelling in cell and cell population biology" is organised, with 25-30 speakers on invitations.

8.2.1.2. Submitted ANR 2015 call "Défi de tous les savoirs".

"Mathematical modelling of dynamics in interacting cell populations" (MMDICP) project submitted for 2015.

8.2.1.3. ANR Blanc 2014-2018 "Kibord".

This recently accepted project gather several members of the Mamba team together with the ENS Cachan and Université Paris-Dauphine on the mathematical study of PDE models with application to biology.

8.2.1.4. ANR 2014-2017 IFLOW.

Eric Vibert, Hopital Paul Brousse (coordinator). Partners: Inria REO, Hopital Toulouse, Dirk Drasdo. Objectives are simulation of liver perfusion after partial hepatectomy (PHx) with and without therapeutic manipulations to improve patients survival after PHx.

8.2.1.5. INSERM 2014 - 2016, INVADE.

Emmanuel Barillot, Institut Curie (coordinateur). Partners: Groups from Institut Curie, Dirk Drasdo. Objective is a model for a better understanding of breast cancer invasion.

8.3. European Initiatives

8.3.1. FP7 & H2020 Projects

8.3.1.1. NOTOX

Type: COOPERATION

Instrument: Integrated Project

Duration: January 2011 - December 2015

Inria contact: Dirk Drasdo

NOTOX will develop and establish a spectrum of systems biological tools including experimental and computational methods for (i) organotypic human cell cultures suitable for long term toxicity testing and (ii) the identification and analysis of pathways of toxicological relevance. NOTOX will initially use available human HepaRG and primary liver cells as well as mouse small intestine cultures in 3D systems to generate own experimental data to develop and validate predictive mathematical and bioinformatic models characterizing long term toxicity responses. Cellular activities will be monitored continuously by comprehensive analysis of released metabolites, peptides and proteins and by estimation of metabolic fluxes using 13C labelling techniques (fluxomics). At selected time points a part of the cells will be removed for in-depth structural (3D-optical and electron microscopy tomography), transcriptomic, epigenomic, metabolomic, proteomic and fluxomic characterisations ("-omics data"). When applicable, cells derived from human stem cells (hESC or iPS) and available human organ simulating systems or even a multi-organ platform developed in SCREENTOX and HEMIBIO will be investigated using developed methods. Together with curated literature and genomic data these toxicological data will be organised in a toxicological database (cooperation with DETECTIVE, COSMOS and TOXBANK). Physiological data including metabolism of test compounds will be incorporated into large-scale computer models that are based on material balancing and kinetics. Various "-omics data" and 3D structural information from organotypic cultures will be integrated using correlative bioinformatic tools. These data also serve as a basis for large scale mathematical models. The overall objectives are to identify cellular and molecular signatures allowing prediction of long term toxicity, to design experimental systems for the identification of predictive endpoints and to integrate these into causal computer models.

Webpage: http://notox-sb.eu/fp7-cosmetics-europe/

8.3.2. Collaborations with Major European Organizations

U. Klingmüller: DKFZ (German Cancer Center), Department for Systemsbiology (Germany)

Role of HGF in liver regeneration. Lung cancer.

K. Breuhahn: University Hospital of Heidelberg, Pathology (Germany)

Lung cancer invasion. Role of HGF in liver regeneration.

JG Hengstler: Leibniz Center, IfADo (Germany)

Liver research, toxicology, regeneration.

University of Leipzig, Interdisciplinary center for bioinformatics (Germany)

Projects on tissue regeneration, software

Nick Jagiella, Helmholz Center, Institute of Computational Biology

Image guided model parameterisation

8.4. International Initiatives

8.4.1. German Bundesministerium für Bildung und Forschung (BMBF) initiatives

1. German Research Ministry (BMBF) funded project on the systems biology of lung cancer. The major aim is to better understand the early metastasis formation and invasion of lung cancer, including therapeutical options. Data on all levels ranging from intracellular up to organ level will be used to establish successively an integrated multiscale model of cellular and migration decisions in lung cancer. A particular focus will be on

dissecting how cellular organisation and communication in spheroid cultures and co-cultures of lung cancer cell lines with selected endothelial cells affects information processing and the proliferation and migration decisions downstream. To reveal the inhomogeneous spatio-temporal organisation in these tumour growth models, specific probes for medical imaging, quantify extracellular cytokine concentrations will be used, and the effects of pharmacological inhibitors be monitored. By data and model integration, parameters should be identified that critically determine early spread and facilitate to predict possibilities for improved therapeutic options. The project coordinator is Ursula Klingmueller, German Cancer Research Centre (DKFZ), Heidelberg (http://www.lungsys.de/)

2. German Research Ministry (BMBF) funded project on the systems biology of liver (Virtual Liver Network). The aim of the VLN project is to set up multiscale models of liver. The Virtual Liver will be a dynamic model that represents, rather than fully replicates, human liver physiology morphology and function, integrating quantitive data from all levels of organisation. Our part ranges from the intracellular up to the level of groups of liver lobules. A liver lobule is the basic repetitive functional unit of liver. Applications are explained in the text available on the web site. The networks has 69 Principle Investigators organised in about 10 work packages, each of which have a number of sub-projects (http://www.virtual-liver.de/).

8.4.2. Participation In other International Programs

Participation in the EuroMed3+3 governed by Inria. The M3CD network (https://www.rocq.inria.fr/bang/M3CD_website/), coordinated by J. Clairambault, has continued and extended its activities, giving rise to new participations: Politecnico di Torino (M. Delitala), Universidad de Valladolid (Ó. Angulo), to stays of students (Y. Bourfia) and researchers (M. Adimy) and to the organisation of a new workshop in Marrakesh in January 2014. The mid-term report is available on the website. The University of Tlemcen (T. Touaoula) has joined in from January 2015.

8.5. International Research Visitors

8.5.1. Visits of International Scientists

Invitation of Min Tang (Shanghai Jao Tong University, China) during one month at UPMC.

8.5.1.1. Internships

Eugenio Lella, Mathematics: Towards a spatio-temporal hybrid mathematical model to simulate drug toxicity in vitro. (2014, master thesis)

8.5.1.2. Research stays abroad

Nicolas Vauchelet stayed two months at IMPA, Rio de Janeiro, Brazil, in the framework of a teaching agreement between UPMC and IMPA.

<p align="center" style="color:red">**MYCENAE Project-Team**</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

PSL☆ project NeuroMathematics (of Sensory Switch)- NeuroMath(SensoS)

7.2. National Initiatives

7.2.1. *ANR*

Jonathan Touboul is member of the ANR Kibord (KInetic models in Biology Or Related Domains) obtained in 2014.

7.2.2. *National Networks*

- GdR REPRO (member of the direction board, F. Clément)
- DLeRBio network: Dynamiques Lentes-Rapides avec applications Biologiques (animation, M. Desroches)
- MIA REM network: Réduction de modèles (PI Béatrice Laroche, INRA Jouy)

7.2.3. *National Collaborations*

- Center for Interdisciplinary Research in Biology, Collège de France (Alain Prochiantz)
- Jacques-Louis Lions Laboratory, Pierre & Marie Curie University (Jean-Pierre Françoise, Marie Postel)
- UMR Physiologie de la Reproduction et des Comportements, INRA Tours (Bios and Bingo teams)
- Group for Neural Theory, École Normale Supérieure, Paris (Boris Gutkin)
- Centre de Recherche en Mathématiques de la Décision, Paris Dauphine University (Stéphane Mischler)
- Computational Biology and Biomathematics, Jacques Monod Institute, Paris Diderot University (Khashayar Pakdaman)
- LAGA (Laboratoire Analyse, Géométrie et Applications), Paris-Nord University (Gilles Wainrib)
- Unité de Neurosciences, Information & Complexité (UNIC), CNRS Gif-sur-Yvette (Alain Destexhe)

7.3. International Initiatives

7.3.1. *Inria International Partners*

7.3.1.1. Informal International Partners

- **USA**: Florida State University (Richard Bertram, Patrick Fletcher, Joël Tabak), University of Pittsburgh (Bard Ermentrout, Jonathan Rubin), Princeton University (William Bialek, Thibault Taillefumier)
- **UK**: University of Bristol (Alan R. Champneys), University of Nottingham (Daniele Avitabile), Plymouth University (Serafim Rodrigues)
- **Spain**: University of the Balearic Islands (Antonio .E. Teruel, Rafel Prohens), Polytechnic University of Catalunya (Toni Guillamon), University of Sevilla (Enrique Ponce)
- **Denmark**: Technical University of Denmark (Morten Brøns and Frank Schilder)

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- William Bialek (Princeton University), May 2014
  seminar More than the sum of their parts: Collective behavior in flocks of birds and networks of neurons, Grands séminaires du Collège de France

- Bard Ermentrout (University of Pittsburgh), June 2014
  seminar Keeping the beat : Homeostatic frequency control in coupled oscillators held in EITN (European Institute for Theoretical Neuroscience)

- Jacques Cowan (University of Chicago, USA), October 2014 (two weeks)
  Mathematics of the Brain Colloquium

- Alexey Kuznetsov (Indiana University-Purdue, University Indianapolis, USA, July 2014 (one week
  seminar A highly-reduced model of the dopaminergic neuron: mechanisms of oscillations

- Martin Wechselberger (University of Sydney, Australia), November 2014 (one week)
  seminar Neuronal Excitability and Canards

7.4.2. Visits to International Teams

7.4.2.1. Research stays abroad

- M. Desroches, one-month research stay in the Department of Mathematics of the University of the Balearic Islands (UIB, Palma, Spain), funded by a scholarship from the UIB, in the framework of a collaboration with Antonio E. Teruel and Rafel Prohens (June 2014).

- J. Touboul, twice one-month research stay in Princeton University, partially funded by the NeuroInfo PEPS PTI project, in the framework of a collaboration with the group of William Balek (March 2014 and December 2014).

<p align="center" style="color:red">POMDAPI Project-Team</p>

7. Partnerships and Cooperations

7.1. Regional Initiatives

GT Elfic (Labex DigiCosme, 2014–2016): "Programmes d'éléments finis formellement vérifiés", with TOCCATA (Inria Saclay - Île-de-France), LIX (École Polytechnique), CEA LIST, LIPN (Université de Paris 13), and LMAC (Université de Technologie de Compiègne).

7.2. National Initiatives

ANR DEDALES (2014–2017): "Algebraic and Geometric Domain Decomposition for Subsurface Flow". The project aims at developing high performance software for the simulation of two phase flow in porous media. The project will specifically target parallel computers where each node is itself composed of a large number of processing cores, such as are found in new generation many-core architectures. The partners are HIEPACS, Laboratoire Analyse, Géométrie et Application, Maison de la Simulation and Andra. The coordinator of the project is M. Kern.

ANR GEOPOR (2014–2017): "Geometrical approach for porous media flows: theory and numerics", with Laboratoire Jacques-Louis Lions (Université de Paris 6).

ANR MANIF (2011–2014): "Mathematical and numerical issues in first-principle molecular simulation", with CERMICS (École Nationale des Ponts et Chaussées), and Laboratoire Jacques-Louis Lions (Université de Paris 6).

C2S@Exa (Computer and Computational Sciences at Exascale, 2011–2015) is an Inria Project Lab (IPL). This national initiative aims at the development of numerical modeling methodologies that fully exploit the processing capabilities of modern massively parallel architectures in the context of a number of selected applications related to important scientific and technological challenges for the quality and the security of life in our society. This project supports in particular the PhD of N. Birgle, supervised by. J. Jaffré, which is part of an Inria-Andra collaboration.

Projet P (2011–2015) is funded by the French FUI (*Fonds Unique Interministériel*). Project P aims at supporting the model-driven engineering of high-integrity embedded real-time systems by providing an open code generation framework. The contribution of project-team Pomdapi is in the domain of language translation and block-schema modelization semantics. This project supports the work of C. Franchini, under the supervision of P. Weis.

7.3. European Initiatives

7.3.1. Collaborations in European Programs, except FP7 & H2020

Program: Research, Development and Innovation Council of the Czech Republic

Project acronym: MORE

Project title: Implicitly constituted material models: from theory through model reduction to efficient numerical methods

Duration: September 2012–September 2017

Coordinator: Josef Málek, Charles University in Prague

Other partners: Institute of Mathematics, Academy of Sciences of the Czech Republic; Oxford Centre for Nonlinear Partial Differential Equations, Great Britain.

Abstract: A multidisciplinary project on nonlinear Navier–Stokes flows with implicit constitutive laws. It focuses on development of accurate, efficient, and robust numerical methods for simulations of the new class of implicit models, see http://more.karlin.mff.cuni.cz/.

7.4. International Initiatives

7.4.1. Participation In other International Programs

Pomdapi is part of the EuroMediterranean 3+3 program with the project HYDRINV (2012–2015): Direct and inverse problems in subsurface flow and transport. Besides Inria, institutions participating in this project are: Universitat Politècnica de Catalunya (Barcelona, Spain), Universidad de Sevilla (Spain), École Mohamedia d'Ingénieurs (Rabat, Morocco), Université Ibn Tofaïl (Kenitra, Morocco), University Centre of Khemis Miliana (Algeria), École Nationale d'Ingénieurs de Tunis (Tunisia).

7.5. International Research Visitors

7.5.1. Visits of International Scientists

Todd Arbogast, professor, Center for Subsurface Modeling, The University of Texas at Austin. September 2014.

Peter Bastian, professor, Interdisciplinary Center for Scientific Computing, University of Heidelberg. June 2014.

H. Ben Ameur, professor at IPEST and member of ENIT-Lamsin, Tunis, Tunisia. June and December 2014.

G. D. Veerappa Gowda, professor, Tata Institute for Fundamental Research, Center for Applicable Mathematics, Bengalore. November-December 2014.

7.5.1.1. Internships

E. Ahmed, from École Nationale d'Ingénieurs de Tunis (Tunisia), has visited Pomdapi for nine months on the subject *Modélisation d'écoulements diphasiques dans un milieu poreux fracturé*.

F. Cheikh, from École Nationale d'Ingénieurs de Tunis (Tunisia), has visited Pomdapi for six months on the subject *Identification de failles dans un milieu poreux par une méthode d'indicateurs*.

M. H. Riahi, from École Nationale d'Ingénieurs de Tunis (Tunisia), has visited Pomdapi for six months on the subject *Identification de paramètres hydrogéologiques dans un milieu poreux*.

7.5.2. Visits to International Teams

7.5.2.1. Research stays abroad

M. Vohralík, April 1st–May 9th. Research stay in the framework of the project MORE "Implicitly constituted material models: from theory through model reduction to efficient numerical methods", Charles University in Prague, see http://more.karlin.mff.cuni.cz/.

REO Project-Team

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. ANR Project "EXIFSI"
Participants: Benoit Fabrèges, Miguel Ángel Fernández Varela [Principal Investigator], Mikel Landajuela Larma, Marina Vidrascu.

Period: 2012-2016
The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to study mathematically and numerically new numerical methods for incompressible fluid-sructure interaction.

8.1.1.2. ANR Project "CARDIOXCOMP"
Participants: Muriel Boulakia, Damiano Lombardi, Jean-Frédéric Gerbeau [Principal Investigator], Fabien Raphel, Eliott Tixier.

Period: 2013-2013.
This project, coordinated by Jean-Frédéric Gerbeau, is carried out in the framework of a joint laboratory ("LabCom" call of ANR) with the software company NOTOCORD. The focus is the mathematical modeling of a device measuring the electrical activity of cardiomyocytes. The overall objective of CardioXcomp is to enrich NOTOCORD's software with modelling and simulation solutions and provide to pharmacology research a completely new set incorporating state of the art signal processing and numerical simulation.

8.1.1.3. ANR Project "iFLOW"
Participants: Chloé Audebert, Jean-Frédéric Gerbeau, Irène Vignon-Clementel [co-Principal Investigator].

Period: 2013-2017.
This ANR-TecSan, co-managed by Eric Vibert (Paul Brousse Hospital) and Irene Vignon-Clementel, aims at developing an Intraoperative Fluorescent Liver Optimization Workflow to better understand the relationship between architecture, perfusion and function in hepatectomy.

Other partners: DHU Hepatinov - Hôpital Paul Brousse, Inria Mamba, Fluoptics, IfADo, MID.

8.1.1.4. Participation to other ANR projects
- Céline Grandmont is a member of the ANR TecSan Oxhelease
- Marina Vidrascu is a member of the ANR ARAMIS

8.1.2. Inria initiatives

8.1.2.1. ADT Project "MENAMES "
Participants: Miguel Ángel Fernández Varela [Principal Investigator], Axel Fourmont, Marina Vidrascu.

Period: 2014-2016
The aim of this project, coordinated by Miguel Ángel Fernández Varela, is to implement in the FELiScE library several algorithms included in the shelddon library, in particular shell elements and domain decomposition methods.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. REVAMMAD

Participants: Matteo Aletti, Jean-Frédéric Gerbeau [correspondant], Damiano Lombardi.

Type: FP7-PEOPLE

Instrument: Marie Curie Initial Training Network

Duration: April 2013 - March 2017

Coordinator: Andrew Hunter, University of Lincoln (UK)

Partner: See the http://revammad.blogs.lincoln.ac.uk/partners/ web site

Inria contact: J-F Gerbeau

Abstract: http://revammad.blogs.lincoln.ac.uk REVAMMAD is a European Union project aimed at combatting some of the EU's most prevalent chronic medical conditions using retinal imaging. The project aims to train a new generation of interdisciplinary scientists for the academic, clinical and industrial sectors, and to trigger a new wave of biomedical interventions. The role of REO team within this consortium is to propose a mathematical model and a simulation tool for the retina hemodynamics.

8.3. International Initiatives

8.3.1. Inria International Labs

Participants: Céline Grandmont, Jessica Oakes, Irène Vignon-Clementel [correspondant].

Period: 2014-2015

Jessica Oakes was awarded an Inria@SiliconValley Grant for a post-doc at UC Berkeley to work on aerosol deposition in the lung.

8.3.2. Trans-Atlantic Network of Excellence for Cardiovascular Research

Participants: Grégory Arbia, Jean-Frédéric Gerbeau, Sanjay Pant, Irène Vignon-Clementel [correspondant].

Period: 2010-2015

This network, funded by the Leducq fondation, is working on the multi-scale modeling of single ventricle hearts for clinical decision support.

Other partners: see http://modelingventricle.clemson.edu/home.

8.3.3. German BMBF national project Lungsys II

Participant: Irène Vignon-Clementel.

Period: 2012-2015

"Systems Biology of Lung Cancer: Dynamic Properties of Early Spread and Therapeutic Options". In collaboration with Dirk Drasdo (EPI Mamba).

Other partners: see http://www.lungsys.de.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- Stephanie Lindsey, PhD student at Cornell University (USA), Aug 2013 - February 2014 & 2 weeks in May 2014
- Weiguang Yang, Engineering research associate, Departments of Pediatrics and Cardiology, Stanford University (USA), May 20th-June 18th 2014
- Andrew Blaber, Carole Leguy, Joke Keijsers, Kouhyar Tavakolian, Simon Fraser University (Vancouver, Canada), May 26 - May 30, 2014

SISYPHE Project-Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. *ANR project SODDA: Soft Defects Diagnosis in wired networks*
Participants: Thomas Lepetit, Mohamed Oumri, Michel Sorine.

The need for detection, localization and characterization of defects in a cable network has led to the ANR projects SEEDS followed by 0-DEFECT in the automotive domain and INSCAN for cables along railways. These projects provide the foundations of diagnosis methods for cables – with a proof of feasibility in the case of hard defects (short-circuit, open circuit) – and some theoretical results on the associated inverse problems in the case of soft faults. They also made it possible to identify their limits. One of the principal limits of these methods, based on the principles of reflectometry, is the difficulty of detecting soft defects. If it was possible to detect and locate precisely these defects, that would help for preventive maintenance or prognosis. The objective of SODDA is to study the signatures of the soft defects, by combining theory and experiment, and to design and test innovative methods adapted to these signatures which are very difficult to detect. The project is run by an academic consortium, in close connection with an industrial board, responsible for keeping the work in realistic and relevant use cases. The Inria teams involved are I4S (Qinghua Zhang), POEMS and Sisyphe.

7.2. International Research Visitors

7.2.1. *Visits to International Teams*

7.2.1.1. *Sabbatical programme*

Bliman Pierre-Alexandre

Date: May 2014 - Apr 2015

Institution: Fundação Getulio Vargas, Brazil EMAp (Brazil)

<p style="text-align:center; color:red;">**ALPINES Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. Medimax

ANR-MN (Modèles Numériques) October 2013 - September 2017

The main goal is the methodological and numerical development of a new robust inversion tool, associated with the numerical solution of the electromagnetic forward problem, including the benchmarking of different other existing approaches (Time Reverse Absorbing Condition, Method of Small-Volume Expansions, Level Set Method). This project involves the development of a general parallel open source simulation code, based on the high-level integrated development environment of FreeFEm++, for modeling an electromagnetic direct problem, the scattering of arbitrary electromagnetic waves in highly heterogeneous media, over a wide frequency range in the microwave domain. The first applications considered here will be medical applications: microwave tomographic images of brain stroke, brain injuries, from both synthetic and experimental data in collaboration with EMTensor GmbH, Vienna (Austria), an Electromagnetic Medical Imaging company.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. EXA2CT

Type: COOPERATION
Instrument: Specific Targeted Research Project
Objectif: NC
Duration: September 2013 - August 2016
Coordinator: Imec, Belgium
Partner: UA Belgium, USI Switzerland, Intel France, NAG England, UVSQ France, T-Systems SfR Germany, IT4Inovations Czech Republic.
Inria contact: Luc Giraud
Abstract: The goal of this project is to develop novel algorithms and programming models to tackle what will otherwise be a series of major obstacles to using a crucial component of many scientific codes at exascale, namely solvers and their constituents. The results of this work will be combined in running programs that demonstrate the application-targeted use of these algorithms and programming models in the form of proto-applications. The application targeting will be done by an analysis of a representative selection of scientific applications using solvers and/or the constituent parts that we target. The results of the project will be disseminated to the reference application owners through a scientific and industrial board (SIB), and board-partner specific code targeting activities, to help generate momentum behind our approach in the HPC community. The proto-applications will serve as a proof-of-concept, a benchmark for doing machine/software co-design, and as a basis for constructing future exascale full applications. In addition, the use of the SIB is a means to extract the commonalities of a range of HPC problems from different scientific domains and different industrial sectors to be able to concentrate on maximising the impact of the project by improving precisely those parts that are common across different simulation needs.
Alpines role: in charge of the Task "Preconditioners" in the working group focusing on numerical algorithms.

7.3. International Initiatives

7.3.1. Inria International Labs

Members of Alpines are part of the International Lab JLPC Etats-Unis.

7.3.2. Inria Associate Teams

7.3.2.1. COALA

Title: Communication Optimal Algoritms for Linear Algebra

International Partner (Institution - Laboratory - Researcher):

University of California Berkeley (ÉTATS-UNIS)

Duration: 2010 - 2015

See also: https://who.rocq.inria.fr/Laura.Grigori/COALA2010/coala.html

Our goal is to continue COALA associated team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations. COALA is an Inria associate team that focuses on the design and implementation of numerical algorithms for today's large supercomputers formed by thousands of multicore processors, possibly with accelerators. We focus on operations that are at the heart of many scientific applications as solving linear systems of equations or least squares problems. The algorithms belong to a new class referred to as communication avoiding that provably minimize communication, where communication means the data transferred between levels of memory hierarchy or between processors in a parallel computer. This research is motivated by studies showing that communication costs can already exceed arithmetic costs by orders of magnitude, and the gap is growing exponentially over time. An important aspect that we consider here is the validation of the algorithms in real applications through our collaborations.

7.3.3. Inria International Partners

7.3.3.1. Informal International Partners

A collaboration focused on the theoretical and numerical analysis for the simulation of wave scattering by means of boundary integral formulation has been in place for several years between Xavier Claeys and the group of Ralf Hiptmair from the Seminar of Applied Mathematics at ETH Zürich.

7.3.4. Participation In other International Programs

Joint Laboratory for Petascale Computing, JLPC Etats-Unis. We take part in this joint effort, in the numerical libraries aspects of the joint laboratory. We collaborate and interact in particular with B. Gropp, UIUC, and J. Brown and M. Knepley, Argonne.

7.4. International Research Visitors

7.4.1. Visits of International Scientists

- Visit of Jed Brown, Argonne National Laboratory, 1 week, June 2014, in the context of JLPC, Etats-Unis.

7.4.1.1. Internships

- Jean-Yves Pallaro, Master 2 student, University of Lille. Jean-Yves worked on LORASC preconditioner.

7.4.2. Visits to International Teams

7.4.2.1. Sabbatical programme

Grigori Laura

Date: Aug 2014 - Aug 2015

Institution: University of California Berkeley (USA)

7.4.2.2. Research stays abroad

- Xavier Claeys, Visit to SAM ETH Zürich for collaboration with Ralf Hitpmair, 3rd August - 16th August 2014.
- Sebastien Cayrols, Visit to UC Berkeley in the context of COALA associated team, December 2014 - April 2015.

<p align="center" style="color:red">**DYOGENE Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. GdR GeoSto

Members of Dyogene participate in Research Group GeoSto (Groupement de recherche, GdR 3477) http://gdr-geostoch.math.cnrs.fr/ on Stochastic Geometry led by Pierre Calka [Université de Rouen]. This is a collaboration framework for all French research teams working in the domain of spatial stochastic modeling, both on theory development and in applications.

8.1.2. ANR

8.1.2.1. ANR GAP

Graphs, Algorithms and Probability - PI: Marc Lelarge; started in Jan 2012 - 48 months. http://www.di.ens.fr/~lelarge/ANR-GAP.html

Over the last few years, several research areas have witnessed important progress through the fruitful collaboration of mathematicians, theoretical physicists and computer scientists. One of them is the cavity method. Originating from the theory of mean field spin glasses, it is key to understanding the structure of Gibbs measures on diluted random graphs, which play a key role in many applications, ranging from statistical inference to optimization, coding and social sciences.

The objective of this project is to develop mathematical tools in order to contribute to a rigorous formalization of the cavity method:

- From local to global, the cavity method on diluted graphs. We will study the extent to which the global properties of a random process defined on some graph are determined by the local properties of interactions on this graph. To this end, we will relate the cavity method to the analysis of the complex zeros of the partition function, an approach that also comes from statistical mechanics. This will allow us to apply new techniques to the study of random processes on large diluted graphs and associated random matrices.

- Combinatorial optimization, network algorithms, statistical inference and social sciences. Motivated by combinatorial optimization problems, we will attack long-standing open questions in theoretical computer science with the new tools developed in the first project. We expect to design new distributed algorithms for communication networks and new algorithms for inference in graphical models. We will also analyze networks from an economic perspective by studying games on complex networks.

8.1.2.2. ANR MARMOTE

Markovian Modeling Tools and Environments - coordinator: Alain Jean-Marie (Inria Maestro); local coordinator (for partner Inria Paris-Rocquencourt): A. Bušić; Started: January 2013; Duration: 48 months; partners: Inria Paris-Rocquencourt (EPI DYOGENE), Inria Sophia Antipolis Méditerranée (EPI MAESTRO), Inria Grenoble Rhône-Alpes (EPI MESCAL), Université Versaillese-St Quentin, Telecom SudParis, Université Paris-Est Creteil, Université Pierre et Marie Curie.

The aim of the project is to realize a modeling environment dedicated to Markov models. One part will develop the Perfect Simulation techniques, which allow to sample from the stationary distribution of the process. A second one will develop parallelization techniques for Monte Carlo simulation. A third one will develop numerical computation techniques for a wide class of Markov models. All these developments will be integrated into a programming environment allowing the specification of models and their solution strategy. Several applications will be studied in various scientific disciplines: physics, biology, economics, network engineering.

8.1.2.3. ANR MAGNUM

A. Bušić was a participant (within partner LIP6) of the national project ANR MAGNUM (Methodes Algorithmiques pour la Generation aleatoire Non Uniforme: Modeles et applications) (2010–2014), partners: LIP6, LIAFA, IGM. http://www-apr.lip6.fr/anrMagnum/.

8.2. International Initiatives

8.2.1. Inria Associate Teams

IT-SG-WN is an Associate Team between the Inria project-team DYOGENE of Inria Paris-Rocquencourt, and the EECS department of UC Berkeley in the USA, funded from 2011 to 2014. This Associate Team participates in the Inria@SiliconValley initiative. The last visit within this program was the one month visit of Prof. Venkat Anantharam (EECS, UC Berkeley). The research work focused on network information theory, and more precisely on error exponents for Gaussian MAC Channels [38] and led to an ISIT submission lately.

8.3. International Research Visitors

8.3.1. Visits of International Scientists

Prof. Pawel Lorek from Wroclaw University (Poland) visited DYOGENE for one week.

Prof. Venkat Anantharam (EECS, UC Berkeley) visited DYOGENE in June 2014, within IT-SG-WN Inria Associate Team.

Prof. A. Rybko and Prof. A. Vladimirov (IITP RAS) visited DYOGNE in June - July 2014.

8.3.2. Visits to International Teams

Ana Bušić visited MIT (2 months) and University of Florida (4 months) from March to August 2014.

<p style="text-align: center; color: red;">**GANG Project-Team**</p>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR Displexity

Participants: Carole Gallet Delporte, Hugues Fauconnier, Pierre Fraigniaud, Amos Korman, Adrian Kosowski, Laurent Viennot.

Managed by University Paris Diderot, C. Delporte and H. Fauconnier lead this project that grants 1 Ph. D.

Distributed computation keep raising new questions concerning computability and complexity. For instance, as far as fault-tolerant distributed computing is concerned, impossibility results do not depend on the computational power of the processes, demonstrating a form of undecidability which is significantly different from the one encountered in sequential computing. In the same way, as far as network computing is concerned, the impossibility of solving certain tasks locally does not depend on the computational power of the individual processes.

The main goal of DISPLEXITY (for DIStributed computing: computability and ComPLEXITY) is to establish the scientific foundations for building up a consistent theory of computability and complexity for distributed computing.

One difficulty to be faced by DISPLEXITY is to reconcile the different sub-communities corresponding to a variety of classes of distributed computing models. The current distributed computing community may indeed be viewed as two not necessarily disjoint sub-communities, one focusing on the impact of temporal issues, while the other focusing on the impact of spatial issues. The different working frameworks tackled by these two communities induce different objectives: computability is the main concern of the former, while complexity is the main concern of the latter.

Within DISPLEXITY, the reconciliation between the two communities will be achieved by focusing on the same class of problems, those for which the distributed outputs are interpreted as a single binary output: yes or no. Those are known as the yes/no-problems. The strength of DISPLEXITY is to gather specialists of the two main streams of distributed computing. Hence, DISPLEXITY will take advantage of the experience gained over the last decade by both communities concerning the challenges to be faced when building up a complexity theory encompassing more than a fragment of the field.

In order to reach its objectives, DISPLEXITY aims at achieving the following tasks:

- Formalizing yes/no-problems (decision problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.

- Formalizing decision problems (yes/no-problems) in the context of distributed computing. Such problems are expected to play an analogous role in the field of distributed computing as that played by decision problems in the context of sequential computing.

- Revisiting the various explicit (e.g., failure-detectors) or implicit (e.g., a priori information) notions of oracles used in the context of distributed computing allowing us to express them in terms of decidability/complexity classes based on oracles.

- Identifying the impact of non-determinism on complexity in distributed computing. In particular, DISPLEXITY aims at a better understanding of the apparent lack of impact of non-determinism in the context of fault-tolerant computing, to be contrasted with the apparent huge impact of non-determinism in the context of network computing. Also, it is foreseen that non-determinism will enable the comparison of complexity classes defined in the context of fault-tolerance with complexity classes defined in the context of network computing.

- Last but not least, DISPLEXITY will focus on new computational paradigms and frameworks, including, but not limited to distributed quantum computing and algorithmic game theory (e.g., network formation games).

The project will have to face and solve a number of challenging problems. Hence, we have built the DISPLEXITY consortium so as to coordinate the efforts of those worldwide leaders in Distributed Computing who are working in our country. A successful execution of the project will result in a tremendous increase in the current knowledge and understanding of decentralized computing and place us in a unique position in the field.

7.1.2. *Laboratory of Information, Networking and Communication Sciences (LINCS)*

Participants: François Durand, The-Dang Huynh, Leonardo Linguaglossa, Laurent Viennot.

Gang is participating to the LINCS, a research centre co-founded by Inria, Institut Mines-Télécom, UPMC and Alcatel-Lucent Bell Labs, dedicated to research and innovation in the domains of future information and communication networks, systems and services. Gang contributes to work on online social networks, content centric networking and forwarding information verification.

7.2. International Initiatives

7.2.1. *Inria International Partners*

7.2.1.1. Informal International Partners

- Carole Delporte and Hugues Fauconnier collaborate with Sam Toueg (Univ. of Toronto) and Rachid Guerraoui (EPFL) on distributed computing and synchronization.
- Carole Delporte, Hugues Fauconnier and Pierre Fraigniaud collaborate on distributed computing with Eli Gafni (UCLA) and Sergio Rajsbaum (Univ. of Mexico).
- Pierre Fraigniaud collaborates with Zvi Lotker (Ben-Gurion Univ.) on social networks.
- Amos Korman collaborates with Ofer Feinerman (Weizmann Institute) on the application of distributed algorithm analysis to ant behaviors.

7.3. International Research Visitors

7.3.1. *Visits of International Scientists*

- Eli Gafni, UCLA, June - July 2014
- Sergio Rajsbaum, Univ. of Mexico, June - July 2014
- Zvi Lotker, Ben-Gurion Univ., September 2014 - July 2015 (Junior chair of the FSMP)

<div align="center">**HIPERCOM2 Team**</div>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. GETRF

Participants: Paul Muhlethaler, Pascale Minet, Cédric Adjih, Emmanuel Baccelli, Philippe Jacquet.

Period: 2012 - 2014.

Partners: DGA/MI, Inria (coordinator), Alcatel-Lucent.

The GETRF project aims at improving the effectiveness of communications mechanisms and technologies capable of functioning in extreme conditions and GETRF also aims at opening ways for solutions that are close to the optimum. The following areas will be addressed:

- Compromise time / maximum efficiency for coloring (TDMA), which can be used to take into account the asymmetry of traffic delays to optimize routing.
- Significant energy savings for opportunistic routing (in power saving mode) even where traffic control is limited and where the nodes are idle most of the time ("low-duty cycle")
- From a completely different point of view, the finding optimal network capacity for opportunistic routing variants when designed for mobile networks
- Robustness to mobility and to changes in network conditions (difficult connectivity, foes, ...) extreme network coding - which is moreover an innovative technology in itself applied here in MANETs, at the network and/or application layer, rather than at the physical/or theoretical level as in other proposals.

The project focuses on four technical approaches which are:

- Coloring for the development of a TDMA system for energy saving and delay control,
- Cross-layer (MAC/routing) mechanism for "low-duty-cycle" mode
- Network coding,
- Opportunistic routing and mobile mobility to use relays to minimize retransmissions of packets with a target time.

The first two approaches are intended to provide energy efficient sensor networks. The second two approaches try to provide mechanisms for building ad hoc networks capable of handling high node mobility.

In this last year of the project we finalize our studies on the four main mechanism of the GETRF project:

- energy saving mechanisms using synchronous techniques,
- energy saving mechanisms using asynchronous techniques,
- network coding,
- mobile routing.

In the last deliverable of the project, we study how these techniques can be combined. We also present how to improve asynchronous techniques for energy saving and how to adapt mobile routing to other assumptions.

8.1.2. Competitivity Clusters

8.1.2.1. SAHARA

Participants: Pascale Minet, Ridha Soua, Erwan Livolant.

Period: 2011 - 2014.

Partners: EADS (coordinator), Astrium, BeanAir, CNES, ECE, EPMI, Eurocopter, GlobalSys, Inria, LIMOS, Oktal SE, Reflex CES, Safran Engineering Systems.

SAHARA is a FUI project, labelled by ASTECH and PEGASE, which aims at designing a wireless sensor network embedded in an aircraft. The proposed solution should improve the embedded mass, the end-to-end delays, the cost and performance in the transfers of non critical data.

During year 2014, we provided support to the SMEs in the SAHARA project for the implementation of network algorithms and protocols.

8.1.2.2. CONNEXION
Participants: Pascale Minet, Ines Khoufi, Erwan Livolant.

Period: 2012 - 2016.

Partners: EDF (coordinator), All4Tec, ALSTOM, AREVA, Atos WorldGrid, CEA, CNRS / CRAN, Corys TESS, ENS Cachan, Esterel Technologies, Inria, LIG, Predict, Rolls-Royce Civil Nuclear, Telecom ParisTech.

The Cluster CONNEXION (Digital Command Control for Nuclear EXport and renovation) project aims to propose and validate an innovative architecture platforms suitable control systems for nuclear power plants in France and abroad. This architecture integrates a set of technological components developed by the academic partners (CEA, Inria, CNRS / CRAN, ENS Cachan, LIG, Telecom ParisTech) and based on collaborations between major integrators such as ALSTOM and AREVA, the operator EDF in France and "techno-providers" of embedded software (Atos WorldGrid, Rolls-Royce Civil Nuclear, Corys TESS, Esterel Technologies, All4Tec, Predict). With the support of the competitiveness clusters System@tic, Minalogic and Burgundy Nuclear Partnership,the project started in April 2012. The key deliverables of the project covered several topics related demonstration concern-driven engineering models for the design and validation of large technical systems, design environments and evaluation of HMI, the implementation of Wireless Sensor Network context-nuclear, buses business object or real-time middleware facilitating the exchange of heterogeneous data and distributed data models standardized to ensure consistency of digital systems.

The HIPERCOM2 team is focuses more particularly on the interconnection of the OCARI wireless sensor network with the industrial facility backbone and deployment algorithms of wireless sensors. In November 2014, we contributed with our Connexion partners to a demonstration showing that OCARI:

- supports wireless sensors of various types (e.g. temperature sensor PT100, smoke detector produced by CEA, fire alarm produced by ADWAVE);
- can be interconnected via a gateway to the industrial facility backbone OPC/UA ROSA developed by Telecom ParisTech to reach the KASEM system in charge of predictive maintenance developed by Predict.

All the chain ranging from the physical sensors, the OCARI wireless network, the OPC/UA bus to the KASEM software was integrated to allow information originated from wireless sensor nodes to be displayed on the KASEM console.

We also focus on deployment algorithms for mobile wireless sensor networks in a temporary worksite or after a disaster. These deployments must ensure coverage and network connectivity. In 2013 we studied solutions to ensure full coverage of the area to monitor as well as network connectivity. We proposed solutions in a first step for autonomous mobile wireless sensor nodes and in a second step for static ones. In May 2014, we showed in a Connexion demonstration a tool displaying the deployment of wireless static sensor nodes in an indoor environment. Since these static nodes are deployed by a mobile robot, we studied how to optimize the exposition duration of a robot in an hostile environment. We also focused on network connectivity, more particularly on how to ensure a reliable connectivity to the sink of sensor nodes located at some points of interest. Our goal is to find the best trade-off between the number of relay nodes deployed and the length of the paths connecting each PoI to the sink.

8.1.2.3. SWAN
Participants: Cédric Adjih, Claudio Greco.

Period: 2011 - 2014

Partners: CNRS, Supélec, Université Paris-Sud (L2S), LTCI, LRI, Inria and IEF.

SWAN, Source-aWAre Network coding, is a DIMLSC DIGITEO project. It deals with network coding for multimedia.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

Paul Muhlethaler was reviewer of the projects:

- E3NETWORK (Energy Efficient E-band transceiver for backhaul of the future networks)
- TROPIC (Distributed computing, storage and radio resource allocation over cooperative femtocells)

8.3. International Initiatives

8.3.1. Participation In other International Programs

8.3.1.1. AWSN 2014

Program: Euromediterranean 3+3

Title: Auto-adaptivity in Wireless Sensor Networks

Inria principal investigator: Pascale Minet

International Partners (Institution - Laboratory - Researcher):

University of Catania (Italy) - DIEEI - Lucia Lo Bello

Ecole Nationale Supérieure d'Informatique et d'Analyse des Systèmes (Morocco) - ND-SRG - Mohamed Erradi

Ecole Nationale des Sciences de l'Informatique (Tunisia) - CRISTAL - Leila Azouz Saidane

Duration: Jan 2012 - Dec 2015

See the Web site: http://hipercom.inria.fr/euromed/

Wireless sensor networks (WSNs) allow the development of numerous applications in various domains, such as security and surveillance, environment protection, precision agriculture, intelligent transportation, homecare of elderly and disabled people...

Communication in such WSNs has to cope with limited capacity resources, energy depletion of sensor nodes, important fluctuations of traffic in the network, changes in the network topology (radio link breakage, interferences ...) or new application requirements. In the AWSN project, we focus on the different techniques to be introduced in the WSNs to make them auto-adaptive with regard to these various changes, while meeting the application requirements. Thus, we address:

- network deployment and redeployment in order to fulfill the application requirements,
- QoS (Quality of Service) optimization taking into account real-time traffic and dynamic bandwidth allocation,
- energy efficiency and replacement of failed sensor node,
- component generation and dynamic adaptation of the application.

In 2014, the AWSN project organized two workshops reserved to AWSN teams:

- Workshop in Rabat in October 2014.
- Workshop in Rocquencourt in December 2014.

The AWSN project organized also open workshops and conferences:

- the RAWSN 2014 workshop in Marrakech in May 2014 organized by the Moroccan team: see the program on http://www.netys.net/rawsn2014/, workshop held in conjunction with NETYS 2014.
- the PEMWN 2014 conference in Sousse in November 2014, organized by the Tunisian and French teams, see the program on https://sites.google.com/site/pemwn2014/final-program

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- **Leila Saidane**, ENSI, Tunis, Tunisia, February and September 2013,
- **Mohammed Erradi**, ENSIAS, Rabat, Morocco, September 2013,
- **Abdellatif Kobbane**, ENSIAS, Rabat, Morocco, September 2013.

MIMOVE Team

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. ANR

7.1.1.1. ANR MURPHY

Participant: Animesh Pathak [correspondent].

- **Name:** MURPHY – *Dependability-focused Evaluation of Sensor Networks*
- **URL:** http://cedric.cnam.fr/~sailhanf/murphy/
- **Related activities:** § 6.6
- **Period:** [January 2011 – September 2014]
- **Partners:** CNAM (**Coordinator**), Inria MiMove, LAAS - CNRS, SmartGrains, Univ. Valenciennes.

Murphy aims at easing the development of dependable and pervasive applications built on top of robust wireless sensor networks, thus providing a mean for early detection of possible failures, by estimating dependability metrics. This endeavor is undertaken by providing:

- Fault detection based on in-network event processing;
- Fault injection that attempts to accelerate the occurrence of faults so as to judge the quality of the error handling and hence, facilitate the evaluation of dependability;
- Advanced code dissemination across sensor networks, which is intended to enable the dynamic and distributed insertion of faults and hide from the end user the complexity related to this task; and
- Suitable abstractions to reason on faults, wireless sensor networks, data-centric and event-driven applications.

The aforementioned components enable to detect faults, diagnose possible causes and select appropriate corrective actions, and therefore to consolidate the dependability of sensor applications.

7.1.2. Inria Support

7.1.2.1. Inria ADT iConnect

Participant: Valérie Issarny [correspondent].

- **Name:** iConnect – *Emergent Middleware Enablers*
- **Related activities:** § 6.3 and 6.4
- **Period:** [October 2013 – December 2015]
- **Partners:** Inria MiMove.

The pervasive computing vision is hampered by the extreme level of heterogeneity in the underlying infrastructure, which impacts on the ability to seamlessly interoperate. Further, the fast pace at which technology evolves at all abstraction layers increasingly challenges the lifetime of networked systems in the digital environment.

Overcoming the interoperability challenge in pervasive computing systems has been at the heart of the FP7 FET IP CONNECT project (http://www.connect-forever.eu/), which ran from 2009 to 2012, and was coordinated by Inria ARLES (MiMove's predecessor team). Specifically, CONNECT has been investigating the paradigm of *Emergent middleware*, where protocol mediators are dynamically synthesized so as to allow networked systems that provide complementary functionalities to successfully coordinate. The CONNECT project has in particular delivered prototype implementation of key enablers for emergent middleware, spanning discovery, protocol learning, and mediator synthesis and deployment. Further, while CONNECT focused on learning and reconciling interaction protocols at the application layer, the FP7 project CHOReOS (http://www.choreos.eu) to which ARLES contributed as well, investigated a complementary enabler that supports interoperability across systems implementing heterogeneous interaction paradigms (i.e., client-service, event-based and shared memory). The proposed enabler introduces the concept of XSB - eXtensible Service Bus, which revisits the notion of Enterprise Service Bus and features an end-to-end interaction protocol that preserves the interaction paradigms of the individual components, while still allowing interoperability.

The objective of the Inria iConnect ADT is to leverage and integrate the above complementary results, packaging and further enhancing enabler prototypes, for take-up of the results by the relevant open source community. The work will involve development effort focused on the following core enablers:

- Universal discovery of resources composing legacy discovery protocols,
- Dynamic synthesis and deployment of mediators specified as enhanced labelled transition systems,
- XSB as underlying run-time support for mediators so as to support interoperability across systems based on heterogeneous interaction paradigms,
- Experiment in the area of federated social networking.

We are releasing the software prototypes through the OW2 open source initiative FISSi (Future Internet Software and Services initiative – http://www.ow2.org/view/Future_Internet/), as our solutions are of direct relevance to sustaining interoperability in the Future Internet.

7.1.2.2. Inria ADT Yarta
Participant: Animesh Pathak [correspondent].

- **Name:** Yarta – *Middleware for mobile social ecosystems*
- **Related activities:** § 6.8
- **Period:** [October 2012 – September 2014]
- **Partners:** Inria MiMove.

Yarta is a middleware for managing mobile social ecosystems, which builds upon existing research in context-awareness in the pervasive computing domain. The work involves development effort in the multi-layer middleware architecture of Yarta, providing the needed functionalities, including: (*i*) Storage of social data in an interoperable format, using semantic technologies such as RDF; (*ii*) Extraction of social ties from context (both physical and virtual); (*iii*) Enforcement of access control to protect social data from arbitrary access; and (*iv*) A rich set of mobile social ecosystem (MSE) management functionalities, using which mobile social applications can be developed. Specifically, the ADT supports the public open source release and evolution of the Yarta middleware, which is currently a research prototype.

7.1.2.3. Inria ADT CityLab Platform
Participant: Animesh Pathak [correspondent].

- **Name:** CityLab Platform – *A Platform for Smarter Cities Promoting Social and Environmental Sustainability*
- **Related activities:** § 6.5
- **Period:** [November 2014 – October 2016]
- **Partners:** Inria MiMove, Inria CLIME.

The CityLab Platform ADT is part of the CityLab Inria Project Lab focused on the study of ICT-based smart city systems from supporting "sensing" systems up to advanced data analytics and new services for the citizens. While the topic is broad, the lab leverages relevant effort within Inria project-teams that is further revisited as well as integrated to meet the challenges of smart cities

There is the promise of enabling radically new ways of living in, regulating, operating and managing cities through the increasing active involvement of citizens. The latest technology trends of crowd- sourcing/sensing (crowd-Xing) and location-based social networking have reignited citizen engagement, opening new perspectives for cost-effective ways of making local communities and cities more sustainable. However, this requires investigating supporting systems of systems from advanced sensing systems up to integrated data management and associated data analytics. This is specifically the objective of the CityLab Inria ProjectLab, where the related ADT is focused on the development and maintenance of the CityLab Platform. The platform integrates the software prototypes developed as part of the undertaken research and will be made available under open source license. It is further the objective of the ADT to deploy and experiment with the platform within cities.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

We provide below information about the latest FP7 project in which we participated, ICT NoE NESSoS, which ended in 2014. We are currently taking part in two H2020 projects, RIA ICT CHOReVOLUTION and RIA ICT FIESTA, which are starting in 2015 and will appear in next year's report.

7.2.1.1. FP7 ICT NoE NESSoS
Participants: Valérie Issarny [correspondent], Animesh Pathak [correspondent].

> **Name:** NESSoS – *Network of Excellence on Engineering Secure Future Internet Software Services and Systems*
>
> **URL:** http://www.nessos-project.eu
>
> **Type:** COOPERATION (ICT)
>
> **Defi:** Trustworthy ICT
>
> **Instrument:** Network of Excellence (NoE)
>
> **Related activities:** § 6.8
>
> **Period:** [October 2010 - March 2014]
>
> **Partners:** Atos Origin (Spain), CNR (Italy) [**coordinator**], ETH Zürich (Switzerland), IMDEA Software (Spain), Inria (teams MiMove, CASSIS, and TRISKELL), KU Leuven (Belgium), LMU München (Germany), Siemens AG (Germany), SINTEF (Norway), University Duisburg-Essen (Germany), Universidad de Malaga (Spain), Università degli studi di Trento (Italy).

The Network of Excellence NESSoS on "Engineering Secure Future Internet Software Services and Systems" aims at constituting and integrating a long lasting research community on engineering secure software-based services and systems. The NESSoS engineering of secure software services is based on the principle of addressing security concerns from the very beginning in system analysis and design, thus contributing to reduce the amount of system and service vulnerabilities and enabling the systematic treatment of security needs through the engineering process. In light of the unique security requirements exposed by the Future Internet, new results are achieved by means of an integrated research, as to improve the necessary assurance level and to address risk and cost during the software development cycle in order to prioritize and manage investments.

7.2.2. Collaborations in European Programs, except FP7

7.2.2.1. EIT ICT Labs 3cixty

Participant: Animesh Pathak [correspondent].

> **Name:** 3cixty – *A Platform for Apps and Services that Offer Comprehensive Views of a City*
> **URL:** http://www.3cixty.com/
> **Period:** [January 2014 - December 2015]
> **Partners:** Ambientic (F), CEFRIEL (IT), DFKI (DE) [**coordinator**], Eurecom (F) [**associate leader**], Fondazione Politechnico di Milano (IT), Innovalor (NL), Inria MiMove [**associate leader**], LocaliData (ES), Mobidot (NL), Politechnico di Milano (IT), Telecom Italia (IT) [**associate leader**], Thales (F), TU Delft (NL), UC London (UK).

3cixty is a platform, well motivated in business terms, for developing apps for city visitors that makes it easy for application developers to access and process comprehensive heterogeneous information about a city; and a Showcase App using the platform that demonstrates its added value. The project will result new opportunities to enable city visitors to exploit the transportation, business, cultural, and touristic opportunities offered by a city more fully and in a more personally and environmentally appropriate way, thereby benefiting cities, their visitors, and application and service developers.

7.3. International Initiatives

7.3.1. Inria International Labs

Valérie Issarny acts as scientific manager of the Inria@Silicon Valley program (https://project.inria.fr/inria-siliconvalley/) since summer 2013; she is visiting scholar at CITRIS, EECS, University of California, Berkeley.

Sara Hachem conducts her postdoc research in the context of the Inria@Silicon Valley program at UC Berkeley.

7.3.2. Inria Associate Teams

7.3.2.1. Inria DRI/DST-CEFIPRA Associate Team: SARATHI

Participant: Animesh Pathak [correspondent].

> **Name:** SARATHI – *Personalized Mobility Services for Urban Travelers*
> **Instrument:** Inria DRI/DST-CEFIPRA Associate Team
> **Period:** [January 2014 - December 2016]
> **Partners:** Indraprastha Institute of Information Technology (IIIT), Delhi (India), Inria MiMove.
> **Website:** https://mimove.inria.fr/inria-associate-team-sarathi/

The focus of the *Sarathi* project is on creating a personalized mobility service platform for urban travelers. The proposed work would require work on large scale mobile participatory sensing, urban transportation, location-aware services, machine learning, and software engineering. The individual strength of MiMove and IIIT provide complementary technical benefits for the project. MiMove leverages its work on large scale mobile participatory sensing (so far focused on EU-based transit contexts) addressing challenges brought to the fore by dynamic large scale systems in India; IIIT will build up on their previous work on mobile based system to provide route information and work on learning and mining techniques for inferring events of interest in transport systems.

Besides the complementary technical benefits, the collaboration will also help the project in evaluating the proposed solution in context of both developing and developed countries with different societal structure and preferences. Since personalized services are an integral part of the solution, the variety in social structures of India and France will help in developing solutions that are valid across continents. A deployment of the proposed solution in India will also test scalability and robustness of the solution in resource-constrained environments (e.g. intermittent network connectivity, low bandwidth) and will help in developing solutions that can be deployed in different working environments. Similarly, France (with already an advanced transit system) offers opportunities in verifying the requirements of a successful sustainable transport system.

7.3.3. Participation in other International Programs

7.3.3.1. International scientific cooperation program Inria/Brazil – Project M@TURE
Participant: Nikolaos Georgantas [correspondent].

Name: M@TURE – *Models @ runtime for self-adaptive pervasive systems*

Instrument: Inria-Brazil cooperation programme

Period: [October 2012 - September 2014]

Partners: Institute of Informatics of Federal University of Goias (Brazil), Inria MiMove.

The overall goal of the M@TURE project is to design, implement and evaluate a novel approach and architecture - comprising conceptual foundations, engineering techniques, and supporting middleware infrastructure - for self-adaptive pervasive systems by building on the notion of Models@run.time. Models@run.time extends the applicability of models and abstractions to the runtime environment. In contrast to design-time models, runtime models are used to reason about the running system taking into account its operating environment, and thus these models enable automating runtime decisions and actions regarding the creation, configuration, and evolution of the system. We in particular focus on the following dimensions and related models: (i) Requirements models making a system requirements-aware at runtime; (ii) Application- and middleware-level interoperability models exposing to an external observer the technological and business features of a system; and (iii) End-user and system engineer models modeling the internal elements of a system at two different abstraction levels. These models are considered both independently and, more importantly, in synergy in order to introduce a comprehensive conceptual and architectural solution for self-adaptive pervasive systems.

7.4. International Research Visitors

7.4.1. Internships

Raphael de Aquino Gomes (from Sep. 2014 until Aug. 2015)

PhD internship funded by a visitor PhD student scholarship of the Brazilian Science without Borders program provided by CAPES and CNPq.

Subject: *Self-Adaptive Use of Cloud Resources for Heterogeneous Dynamic Service Choreographies*

Institution: Federal University of Goias - UFG (Brazil)

8. Partnerships and Cooperations

8.1. European Initiatives

8.1.1. User-Centric Networking (UCN)

Type: FP7

Instrument: Specific Targeted Research Project

Duration: October 2013 - September 2016

Coordinator: Technicolor

Other partners: Eurecom, Fraunhofer FOKUS, Intamac, University of Cambridge, University of Nottingham, Martel, NICTA, Portugal Telecom

Inria contact: Renata Teixeira

Abstract: This project introduces the concept of User Centric Networking (UCN), which is a new paradigm leveraging user information at large to deliver novel content recommendation systems and content delivery frameworks. UCN recommendation and content delivery systems will leverage in-depth knowledge about users to help them find relevant content, identify nearby network resources and plan how to deliver the actual content to the appropriate device at the desired time. These systems will additionally account for influences from users' social networks on their content consumption. The goal of this project is to design a UCN system architecture for user-centric connected media services. We will build UCN upon three complementary research pillars:

1. understanding user context: This data can be broadly categorized into three groups. First, the physical and environmental context A second category of data is that which can be extracted from social network interactions. The third category of data is behavioural

2. profiling and predicting user interests: By gaining a deep understanding of the user, we may be able to cast a much wider net in the content ocean and locate a richer catalogue of interesting content for the user

3. personalizing content delivery: Rather than the user (or the service provider) having to worry about the mode of connectivity, device, service, location, etc., the network intelligently directs and adapts the transport stream, or perhaps pre-fetches and replicates content chunks, to the particular and immediate needs of the user.

See also: http://usercentricnetworking.eu/

8.2. International Initiatives

8.2.1. Informal International Partners

- Georgia Institute of Technology (Prof. Nick Feamster and his doctoral students Srikanth Sundaresan and Sarthak Grover): We have a long-term collaboration on measuring the performance of residential broadband Internet access networks and more recently on home network diagnosis.

- ICSI, UC Berkeley (Prof. Vern Paxson, Dr. Christian Kreibich, Dr. Robin Sommer): With V. Paxson and C. Kreibich, we have been developing Fathom, a browser-based network measurement platform. We are now adding home network diagnosis capabilities to Fathom. In addition, with Robin Sommer we are working on the potential of matching the profiles of a user across multiple online social networks.

8.3. International Research Visitors

8.3.1. Internships

- O. Belkadi, master intern, National School of Applied Sciences (ENSA), Tangier, from Apr 2014 until Aug 2014.

- S. Grover, doctoral intern from Georgia Tech, from May 2014 until Aug 2014.

- M. Santoro, master intern, Universidad Politecnica de Valencia, from May 2014 until Sep 2014.

<p style="text-align:center">**RAP Project-Team**</p>

6. Partnerships and Cooperations

6.1. International Research Visitors

RAP team has received the following people:

- Louigi Addario-Berry (McGill)
- Shankar Bhamidi (University of North Carolina at Chapel Hill)
- Christina Goldschmidt (Oxford)
- Ross Hemsley (Inria Sophia)
- Stefan Langerman (UL Bruxelles)
- Gabor Lugosi (Pompeu Fabra)
- Ahmed Kharroubi (Casablanca, Marrocco)
- Juan Pablo Vigneaux (Santiago, Chile)
- Cecile Mailler (University of Bath)

6.2. National Research Visitors

RAP team has received the following people:

- Nicolas Gast (Inria Grenoble)
- Olivier Devillers (Inria Sophia)
- Marie Albenque (Ecole Polytechnique)

<div align="center">

REGAL Project-Team

</div>

7. Partnerships and Cooperations

7.1. National Initiatives

7.1.1. Labex SMART - (2012–2019)

Members: ISIR (UPMC/CNRS), LIP6 (UPMC/CNRS), LIB (UPMC/INSERM), LJLL (UPMC/CNRS), LTCI (Institut Mines-Télécom/CNRS), CHArt-LUTIN (Univ. Paris 8/EPHE), L2E (UPMC), STMS (IRCAM/CNRS).

Funding: Sorbonne Universités, ANR.

Description: The SMART Labex project aims globally to enhancing the quality of life in our digital societies by building the foundational bases for facilitating the inclusion of intelligent artifacts in our daily life for service and assistance. The project addresses underlying scientific questions raised by the development of Human-centered digital systems and artifacts in a comprehensive way. The research program is organized along five axes and Regal is responsible of the axe "Autonomic Distributed Environments for Mobility."

The project involves a PhD grant of 100 000 euros over 2,5 years.

7.1.2. InfraJVM - (2012–2015)

Members: LIP6 (Regal), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Funding: ANR Infra.

Objectives: The design of the Java Virtual Machine (JVM) was last revised in 1999, at a time when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

The coordinator of InfraJVM is Gaël Thomas, who left the team in 2014. Infra-JVM brings a grant of 202 000 euros from the ANR to UPMC over three years.

7.1.3. Nuage - (2012–2014)

Members: Non Stop Systems (NSS), Oodrive, Alphalink (Init SYS), CELESTE, DotRiver, NewGeneration, LIP6 (Regal et Phare)

Funding: Fonds National pour la Société Numérique, CDC

Objectives: The Nuage project aims at designing and building an open source, energy-aware, cloud based on OpenStack. In this project, the Regal group contributes on the storage axis. In clouds, virtualization forms the basis to ensure flexibility, portability and isolation. However, the price to pay for flexibility and isolation is memory fragmentation. We thus propose to pool unused memory by allowing nodes to use memory of other nodes to extend their cache, at the kernel level.

It involves a grant of 153 000 euros over 2,5 years.

7.1.4. ODISEA - (2011–2014)

Members: Orange, LIP6 (Regal), UbiStorage, Technicolor, Institut Telecom

Funding: FUI project, Ile de France Region

Objectives: ODISEA aims at designing new on-line data storage and data sharing solutions. Current
solutions rely on large data centers, which induce many drawbacks: (i) a high cost, (ii) proprietary
solutions, (iii) inefficiency (one single location, not necessarily close to the user). The goal is to
tackle these issues by designing a distributed/decentralized solution that leverage edge resources
like set-top boxes.

It involves a grant of 159 000 euros from Region Ile de France over three years.

7.1.5. Richelieu - (2012–2014)

Members: LIP6 (Regal), Scilab Entreprise, Silkan, OCaml Pro, Inria Saclay, Arcelor Mittal, CNES,
Dassault Aviation.

Funding: FUI.

Objectives: The goal of Richelieu is to design a new runtime for the Scilab language based on VMKit.
Scilab is a scientific language and its runtime relies on a costly interpretation loop. In the Richelieu
project, we propose to replace the interpretation loop by VMKit, which provides both an efficient
Just In Time Compiler and advanced memory management techniques.

It involves a grant of 135 000 euros from Region Ile de France over two years.

7.1.6. MyCloud (2011–2014)

Members: Inria Rhones-Alpes (SARDES), LIP6 (REGAL), EMN, WeAreCloud, Elastic Cloud.

Funding: MyCloud project is funded by ANR Arpège.

Objectives: Cloud Computing is a paradigm for enabling remote, on-demand access to a set of con-
figurable computing resources. The objective of the MyCloud project is to define and implement
a novel cloud model: SLAaaS (SLA aware Service). Novel models, control laws, distributed algo-
rithms and languages will be proposed for automated provisioning, configuration and deployment of
cloud services to meet SLA requirements, while tackling scalability and dynamics issues. It involves
a grant of 155 000 euros from ANR to LIP6 over three years.

7.1.7. ConcoRDanT (2010–2014)

Members: Inria Regal, project leader; LORIA, Université de Nantes, Universdade Nova de Lisboa.

Funding: ConcoRDanT is funded by ANR Blanc.

Objectives: CRDTs for consistency without concurrency control in Cloud and Peer-To-Peer systems.
Massive computing systems and their applications suffer from a fundamental tension between
scalability and data consistency. Avoiding the synchronisation bottleneck requires highly skilled
programmers, makes applications complex and brittle, and is error-prone. The ConcoRDanT project
investigates a promising new approach that is simple, scales indefinitely, and provably ensures
eventual consistency. A Commutative Replicated Data Type (CRDT) is a data type where all
concurrent operations commute. If all replicas execute all operations, they converge; no complex
concurrency control is required. We have shown in the past that CRDTs can replace existing
techniques in a number of tasks where distributed users can update concurrently, such as co-operative
editing, wikis, and version control. However CRDTs are not a universal solution and raise their own
issues (e.g., growth of meta-data). The ConcoRDanT project engages in a systematic and principled
study of CRDTs, to discover their power and limitations, both theoretical and practical. Its outcome
will be a body of knowledge about CRDTs and a library of CRDT designs, and applications using
them. We are hopeful that significant distributed applications can be designed using CRDTs, a radical
simplification of software, elegantly reconciling scalability and consistency. ConcoRDanT involves
a grant of 192 637 euros from ANR to Inria over three and a half years.

7.1.8. STREAMS (2010–2014)

Members: LORIA (Score, Cassis), Inria (Regal, ASAP), Xwiki.

Funding: STREAMS is funded by ANR Arpège.

Objectives: Solutions for a peer-To-peer REAl-tiMe Social web The STREAMS project proposes to design peer-to-peer solutions that offer underlying services required by real-time social web applications and that eliminate the disadvantages of centralised architectures. These solutions are meant to replace a central authority-based collaboration with a distributed collaboration that offers support for decentralisation of services. The project aims to advance the state of the art on peer-to-peer networks for social and real-time applications. Scalability is generally considered as an inherent characteristic of peer-to-peer systems. It is traditionally achieved using replication techniques. Unfortunately, the current state of the art in peer-to-peer networks does not address replication of continuously updated content due to real-time user changes. Moreover, there exists a tension between sharing data with friends in a social network deployed in an open peer-to-peer network and ensuring privacy. One of the most challenging issues in social applications is how to balance collaboration with access control to shared objects. Interaction is aimed at making shared objects available to all who need them, whereas access control seeks to ensure this availability only to users with proper authorisation. STREAMS project aims at providing theoretical solutions to these challenges as well as practical experimentation. It involves a grant of 57 000 euros from ANR to Inria over three and a half years.

7.2. European Initiatives

7.2.1. FP7 & H2020 Projects

7.2.1.1. SyncFree

Type: COOPERATION

Challenge: Pervasive and Trusted Network and Service Infrastructures

Instrument: Specific Targeted Research Project

Objectives: ICT-2013.1.2 "Software Engineering, Services and Cloud Computing," ICT-2013.1.6 "Connected and Social Media"

Duration: October 2013 - September 2016

Coordinator: Marc Shapiro (Inria)

Partners: Inria (Regal & Score), Basho Technologies Inc., Trifork A/S, Rovio Entertainment Oy, U. Nova de Lisboa, U. Catholique de Louvain, Koç U., Technische U. Kaiserslautern.

Inria contact: Marc Shapiro

Abstract: The goal of SyncFree is to enable large-scale distributed applications *without global synchronisation*, by exploiting the recent concept of *Conflict-free Replicated Data Types* (CRDTs). CRDTs allow unsynchronised concurrent updates, yet ensure data consistency. This radical new approach maximises responsiveness and availability; it enables locating data near its users, in decentralised clouds.

Global-scale applications, such as virtual wallets, advertising platforms, social networks, online games, or collaboration networks, require consistency across distributed data items. As networked users, objects, devices, and sensors proliferate, the consistency issue is increasingly acute for the software industry. Current alternatives are both unsatisfactory: either to rely on synchronisation to ensure strong consistency, or to forfeit synchronisation and consistency altogether with ad-hoc eventual consistency. The former approach does not scale beyond a single data centre and is expensive. The latter is extremely difficult to understand, and remains error-prone, even for highly-skilled programmers.

SyncFree avoids both global synchronisation and the complexities of ad-hoc eventual consistency by leveraging the formal properties of CRDTs. CRDTs are designed so that unsynchronised concurrent updates do not conflict and have well-defined semantics. By combining CRDT objects from a standard library of proven datatypes (counters, sets, graphs, sequences, etc.), large-scale distributed programming is simpler and less error-prone. CRDTs are a practical and cost-effective approach.

The SyncFree project will develop both theoretical and practical understanding of large-scale synchronisation-free programming based on CRDTs. Project results will be new industrial applications, new application architectures, large-scale evaluation of both, programming models and algorithms for large-scale applications, and advanced scientific understanding.

7.2.2. Collaborations in European Programs, except FP7 & H2020

Program: COST Action IC1001

Project acronym: Euro-TM

Project title: Transactional Memories: Foundations, Algorithms, Tools, and Applications

Duration: 2011–2015

Coordinator: Dr. Paolo Romano (INESC)

Other partners: Austria, Czech Republic, Denmark, France, Germany, Greece, Israel, Italy, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Inria contact: Marc Shapiro

Abstract: Parallel programming (PP) used to be an area once confined to a few niches, such as scientific and high-performance computing applications. However, with the proliferation of multicore processors, and the emergence of new, inherently parallel and distributed deployment platforms, such as those provided by cloud computing, parallel programming has definitely become a mainstream concern. Transactional Memories (TMs) answer the need to find a better programming model for PP, capable of boosting developers' productivity and allowing ordinary programmers to unleash the power of parallel and distributed architectures avoiding the pitfalls of manual, lock based synchronization. It is therefore no surprise that TM has been subject to intense research in the last years. This Action aims at consolidating European research on this important field, by coordinating the European research groups working on the development of complementary, interdisciplinary aspects of Transactional Memories, including theoretical foundations, algorithms, hardware and operating system support, language integration and development tools, and applications.

7.2.3. Collaborations with Major European Organizations

Ecole Polytechnique Fédérale de Lausanne, Distributed Programming Laboratory (Switzerland)

Caracterization of the weakest failure detector for eventual consistency

7.3. International Initiatives

7.3.1. Inria Associate Teams

7.3.1.1. ARMADA

Title: hARnessing MAssive DAta flows

International Partner (Institution - Laboratory - Researcher):

Universidad Tecnica Federico Santa Maria (CHILI)

Duration: 2014 - 2016

See also: http://web.inria-armada.org

The ARMADA project aims at designing and implementing a reliable framework for the management and processing of massive dynamic dataflows. The project is two-pronged: fault-tolerant middleware support for processing massive continuous input, and a redundant storage service for mutable data on a massive scale.

7.3.2. Inria International Partners

7.3.2.1. Declared Inria International Partners

7.3.2.1.1. PHC MAIMONIDE

Title: Application Dependent Intrusion (Byzantine) Detection in Dynamic Cloud Systems

International Partner (Institution - Laboratory - Researcher):

Technion, Haifa (Israel)

Duration: 2014 – 2015

The goal of this project is to study the ability to detect intrusions, and more broadly Byzantine failures, in standard cloud services. The goal is to provide a formal model and a corresponding formal definition of Byzantine failure detection in dynamic cloud environments, and provide formally provable implementations of these detectors. We also intend to study how to combine such Byzantine failure detectors in standard open source cloud building blocks, such as ZooKeeper, Hadoop, and Cassandra, and harden them in order to make them resilient to such attacks.

7.3.3. Participation In other International Programs

Luciana Arantes and Olivier Marin participated to the STIC-AmSud project RESPOND, which ended with a workshop in Punta Arenas, Chile, from November 17th to November 21st, 2014

7.4. International Research Visitors

7.4.1. Visits of International Scientists

Serdar Tasiran

Date: 07/2014 – 09/2014

Institution: Koç University (Turkey)

Anubis Graciela de Moraes Rossetto

Date: 03/2014 – 05/2014

Institution: Federal University of Rio Grande do Sul Porto Alegre (Brazil)

Vivien Quéma

Date: 01/2014 – 08/2014

Institution: LIG (FRANCE)

7.4.1.1. Internships

Dastagiri Reddy Malikireddy

Date: May–Aug 2014

Institution: IIT Kharagpur, India.

<p align="center" style="color:red">WHISPER Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

InfraJVM - (2012 - 2015)

Members: LIP6 (Regal-Whisper), Ecole des Mines de Nantes (Constraint), IRISA (Triskell), LaBRI (LSR).

Coordinator: Gaël Thomas

Whisper members: Julia Lawall, Gilles Muller

Funding: ANR Infra, 202 000 euros.

Objectives: The design of the Java Virtual Machine(JVM) was last revised in 1999, at atime when a single program running on a uniprocessor desktop machine was the norm. Today's computing environment, however, is radically different, being characterized by many different kinds of computing devices, which are often mobile and which need to interact within the context of a single application. Supporting such applications, involving multiple mutually untrusted devices, requires resource management and scheduling strategies that were not planned for in the 1999 JVM design. The goal of InfraJVM is to design strategies that can meet the needs of such applications and that provide the good performance that is required in an MRE.

Chronos network, Time and Events in Computer Science, Control Theory, Signal Processing, Computer Music, and Computational Neurosciences and Biology

Coordinator: Gerard Berry

Whisper member: Gilles Muller

Funding: ANR 2014, Défi "Société de l'information et de la communication".

The Chronos interdisciplinary network aims at placing in close contact and cooperation researchers of a variety of scientific fields: computer science, control theory, signal processing, computer music, neurosciences, and computational biology. The scientific object of study will be the understanding, modeling, and handling of time- and event-based computation across the fields.

Chronos will work by organizing a regular global seminar on subjects ranging from open questions to concrete solutions in the research fields, workshops gathering subsets of the Chronos researchers to address specific issues more deeply, a final public symposium presenting the main contributions and results, and an associated compendium.

8.1.2. Multicore Inria Project Lab

The Multicore IPL is an Inria initiative led by Gilles Muller, whose goal is to develop techniques for being able to deploy parallel programs on heterogeneous multicore machines while preserving scalability and performance. The IPL brings together researchers from the ALF, Algorille, CAMUS, Compsys, DALI, REGAL, Runtime and Whisper Inria Teams. These connections provide access to a diversity of expertise on open source development and parallel computing, respectively. In this context, we are working with Jens Gustedt of Inria Lorraine and on developing a domain-specific language that eases programming with the ordered read-write lock (ORWL) execution model. The goal of this work is to provide a single execution model for parallel programs and allow them to be deployed on multicore machines with varying architectures.

8.2. European Initiatives

8.2.1. Collaborations in European Programs, except FP7 & H2020

Program: COST Action IC1001

Project acronym: Euro-TM

Project title: Transactional Memories: Foundations, Algorithms, Tools, and Applications

Duration: 2011 - 2014

Coordinator: Dr. Paolo Romano (INESC)

Whisper member: Gilles Muller, leader of the working group on Hardware's & Operating System's Supports

Other partners: Austria, Czech Republic, Denmark, France, Germany, Greece, Israel, Italy, Norway, Poland, Portugal, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom.

Abstract: Parallel programming (PP) used to be an area once confined to a few niches, such as scientific and high-performance computing applications. However, with the proliferation of multicore processors, and the emergence of new, inherently parallel and distributed deployment platforms, such as those provided by cloud computing, parallel programming has definitely become a mainstream concern. Transactional Memories(TMs) answer the need to find a better programming model for PP, capable of boosting developer's productivity and allowing ordinary programmers to unleash the power of parallel and distributed architectures avoiding the pitfalls of manual, lock based synchronization. It is therefore no surprise that TM has been subject to intense research in the last years. This Action aims at consolidating European research on this important field, by coordinating the European research groups working on the development of complementary, interdisciplinary aspects of Transactional Memories, including theoretical foundations, algorithms, hardware and operating system support, language integration and development tools, and applications.

8.3. International Initiatives

8.3.1. Participation In other International Programs

Julia Lawall obtained the renewal of a Merlion collaboration grant, started in 2013, for collaboration with David Lo of Singapore Management University. This collaboration resulted in a two-week visit of Julia Lawall to Singapore Management University, a one-week visit of David Lo to the Whisper team, and a two-week visit of Lo's PhD student Ferdian Thung to the Whisper team. It also resulted in four publications during 2014 [26], [21], [23], [19].

8.4. International Research Visitors

8.4.1. Visits of International Scientists

8.4.1.1. Internships

Julia Lawall supervised the remote internships of Himangi Saraogi (summer 2014) and Tapasweni Pathak (winter 2014, in progress) as part of the Gnome Outreach Program for Women (OPW). Both interns carried out projects related to Coccinelle and the Linux kernel. Julia Lawall has taken over the responsability for the coordination of the Linux kernel's participation in the OPW program in winter 2014.

Julia Lawall also supervised the internship of the undergraduate student (L2) Chi Pham from the University of Copenhagen. Pham developed a tool for transforming Coccinelle semantic patches to make them suitable for inclusion in the Linux kernel.

<p align="center" style="color:red">ALPAGE Project-Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. LabEx EFL (Empirical Foundations of Linguistics) (2011 – 2021)

Participants: Laurence Danlos, Benoît Sagot, Chloé Braud, Marie-Hélène Candito, Benoit Crabbé, Pierre Magistry, Djamé Seddah, Sarah Beniamine, Maximin Coavoux, Éric Villemonte de La Clergerie.

Linguistics and related disciplines addressing language have achieved much progress in the last two decades but improved interdisciplinary communication and interaction can significantly boost this positive trend. The LabEx (excellency cluster) EFL (Empirical Foundations of Linguistics), launched in 2011 and headed by Jacqueline Vaissière, opens new perspectives by adopting an integrative approach. It groups together some of the French leading research teams in theoretical and applied linguistics, in computational linguistics, and in psycholinguistics. Through collaborations with prestigious multidisciplinary institutions (CSLI, MIT, Max Planck Institute, SOAS...) the project aims at contributing to the creation of a Paris School of Linguistics, a novel and innovative interdisciplinary site where dialog among the language sciences can be fostered, with a special focus on empirical foundations and experimental methods and a valuable expertise on technology transfer and applications.

Alpage is a very active member of the LabEx EFL together with other linguistic teams we have been increasingly collaborating with: LLF (University Paris 7 & CNRS) for formal linguistics, LIPN (University Paris 13 & CNRS) for NLP, LPNCog (University Paris 5 & CNRS) LSCP (ENS, EHESS & CNRS) for psycholinguistics, MII (University Paris 4 & CNRS) for Iranian and Indian studies. Alpage resources and tools have already proven relevant for research at the junction of all these areas of linguistics, thus drawing a preview of what the LabEx is about: experimental linguistics (see Section 4.6). Moreover, the LabEx provides Alpage with opportunities for collaborating with new teams, e.g., on language resource development with descriptive linguists.

Benoît Sagot is the head one of the 7 autonomous scientific "strands" of the LabEx EFL, namely the strand 6 on "Language Resources". Marie-Hélène Candito and Benoit Crabbé are respectively deputy-head of strands 5 on "Computational semantic analysis" and 2 on "Experimental grammar from a cross-linguistic perspective". Several project members are in charge of research operations within these 3 strands.

8.1.2. ANR

8.1.2.1. ANR project ASFALDA (2012 – 2015)

Participants: Marie-Hélène Candito [principal investigator], Marianne Djemaa, Benoît Sagot, Éric Villemonte de La Clergerie, Laurence Danlos, Virginie Mouilleron, Vanessa Combet.

Alpage is principal investigator team for the ANR project ASFALDA, lead by Marie-Hélène Candito. The other partners are the Laboratoire d'Informatique Fondamentale de Marseille (LIF), the CEA-List, the MELODI team (IRIT, Toulouse), the Laboratoire de Linguistique Formelle (LLF, Paris Diderot) and the Ant'inno society.

The project aims to provide both a French corpus with semantic annotations and automatic tools for shallow semantic analysis, using machine learning techniques to train analyzers on this corpus. The target semantic annotations are structured following the FrameNet framework [57] and can be characterized roughly as an explicitation of "who does what when and where", that abstracts away from word order / syntactic variation, and to some of the lexical variation found in natural language.

The project relies on an existing standard for semantic annotation of predicates and roles (FrameNet), and on existing previous effort of linguistic annotation for French (the French Treebank). The original FrameNet project provides a structured set of prototypical situations, called frames, along with a semantic characterization of the participants of these situations (called *roles*). We propose to take advantage of this semantic database, which has proved largely portable across languages, to build a French FrameNet, meaning both a lexicon listing which French lexemes can express which frames, and an annotated corpus in which occurrences of frames and roles played by participants are made explicit. The addition of semantic annotations to the French Treebank, which already contains morphological and syntactic annotations, will boost its usefulness both for linguistic studies and for machine-learning-based Natural Language Processing applications for French, such as content semantic annotation, text mining or information extraction.

To cope with the intrinsic coverage difficulty of such a project, we adopt a hybrid strategy to obtain both exhaustive annotation for some specific selected concepts (commercial transaction, communication, causality, sentiment and emotion, time), and exhaustive annotation for some highly frequent verbs. Pre-annotation of roles will be tested, using linking information between deep grammatical functions and semantic roles.

The project is structured as follows:

- Task 1 concerns the delimitation of the focused FrameNet substructure, and its coherence verification, in order to make the resulting structure more easily usable for inference and for automatic enrichment (with compatibility with the original model);
- Task 2 concerns all the lexical aspects: which lexemes can express the selected frames, how they map to external resources, and how their semantic argument can be syntactically expressed, an information usable for automatic pre-annotation on the corpus;
- Task 3 is devoted to the manual annotation of corpus occurrences (we target 20000 annotated occurrences);
- In Task 4 we will design a semantic analyzer, able to automatically make explicit the semantic annotation (frames and roles) on new sentences, using machine learning on the annotated corpus;
- Task 5 consists in testing the integration of the semantic analysis in an industrial search engine, and to measure its usefulness in terms of user satisfaction.

The scientific key aspects of the project are:

- an emphasis on the diversity of ways to express the same frame, including expression (such as discourse connectors) that cross sentence boundaries;
- an emphasis on semi-supervised techniques for semantic analysis, to generalize over the available annotated data.

8.1.2.2. ANR project Polymnie (2012-2016)
Participants: Laurence Danlos, Éric Villemonte de La Clergerie, Julie Hunter.

Polymnie is an ANR research project headed by Sylvain Podogolla (Sémagramme, Inria Lorraine) with Melodi (INRIT, CNRS), Signes (LABRI, CNRS) and Alpage as partners. This project relies on the grammatical framework of Abstract Categorial Grammars (ACG). A feature of this formalism is to provide the same mathematical perspective both on the surface forms and on the more abstract forms the latter correspond to. ACG allows for the encoding of a large variety of grammatical formalisms, in particular Tree Adjoining grammars (TAG).

The role of Alpage in this project is to develop sentential or discursive grammars written in TAG and to participate in their conversion in ACG. Results were first achieved in 2014 concerning text generation: GTAG formalism created by Laurence Danlos in the 90's has been rewritten in ACG [25], [26], [27]. As regards discursive analysis, D-STAG formalism created by Laurence Danlos in the 00's is currently been rewritten in ACG and enhanced to cover attributions with some preliminary linguistic work on attributions [33].

8.1.3. Other national initiatives

8.1.3.1. "Investissements d'Avenir" project PACTE (2012 – 2015)
Participants: Benoît Sagot, Kata Gábor, Pierre Magistry.

PACTE (*Projet d'Amélioration de la Capture TExtuelle*) is an "Investissements d'Avenir" project sumbitted within the call "Technologies de numérisation et de valorisation des contenus culturels, scientifiques et éducatifs". It started in November 2012, although the associated fundings only arrived at Alpage in July 2013.

PACTE aims at improving the performance of textual capture processes (OCR, manual script recognition, manual capture, direct typing), using NLP tools relying on both statistical (n-gram-based, with scalability issues) and hybrid techniques (involving lexical knowledge and POS-tagging models). It addresses specifically the application domain of written heritage. The project takes place in a multilingual context, and therefore aims at developing as language-independant techniques as possible.

PACTE involves 3 companies (Numen, formerly Diadeis, main partner, as well as A2IA and Isako) as well as Alpage and the LIUM (University of Le Mans). It brings together business specialists, large-scale corpora, lexical resources, as well as the scientific and technical expertise required.

The results obtained at Alpage in 2014 within PACTE are described in 6.3

8.1.3.2. *FUI project COMBI (2014-2016)*
Participants: Laurence Danlos, Vanessa Combet, Jacques Steinlin.

COMBI is is an "FUI 16" project. It started in February 2014 for a two year duration. It groups 5 industrial partners (Temis, Isthma, Kwaga, Yseop and Qunb) and Alpage. Temis and Istma work on data mining from texts and big data. Kwaga works on the interpretation and inferences that can be drawn from the data retrieved in the analysis module. Alpage and Qunb work, under the supervision of Yseop, on the production of respectively texts and graphics describing the results of the interpretation module. Currently, COMBI aims at creating the full chain for a user case concerning the weekly activity of an on-line service.

Alpage works on text generation, with the adaptation of TextElaborator, a generation system developed in the 10's by WatchAssistance and based on G-TAG. Alpage also works on the opportunity to describe pieces of information by texts, graphics or both.

8.1.3.3. *Consortium Corpus Écrits within the TGIR Huma-Num*
Participants: Benoît Sagot, Djamé Seddah.

Huma-Num is a TGIR (Very Large Research Infrastructure) dedicated to digital humanities. Among Huma-Num initiatives are a dozen of consortia, which bring together most members of various research communities. Among them is the *Corpus Écrits* consortium, which is dedicated to all aspects related to written corpora, from NLP to corpus development, corpus specification, standardization, and others. All types of written corpora are covered (French, other languages, contemprorary language, medieval language, specialized text, non-standard text, etc.). The consortium Corpus Écrits is managed by the Institut de Linguistique Française, a CNRS federation of which Alpage is a member since June 2013, under the supervision of Franck Neveu.

Alpage is involved in various projects within this consortium, and especially in the development of corpora for CMC texts (blogs, forum posts, SMSs, textchat...) and shallow corpus annotation, especially with MElt.

8.2. European Initiatives

8.2.1. *Collaborations in European Programs, except FP7 & H2020*

Program: **IC1207 COST**

Project acronym: PARSEME

Project title: PARSing and Multi-word Expressions

Duration: March 2013 - March 2017

Coordinator: Agata Savary

Other partners: interdisciplinary experts (linguists, computational linguists, computer scientists, psycholinguists, and industrials) from 30 countries

Abstract: The general aim of PARSEME is increasing and enhancing the ICT support of the European multilingual heritage. This aim is pursued via more detailed objectives: (1) to put multilingualism in focus of linguistic and technological studies; (2) to establish a long-lasting cross-lingual, cross-theoretical and cross-methodological research network in natural language processing (NLP); (3) to bridge the gap between linguistic precision and computational efficiency in NLP applications.

Program: **ISCH COST Action IS1312**

Project acronym: TextLink

Project title: Structuring Discourse in Multilingual Europe

Duration: April 2014 - April 2018

Coordinator: Liesbeth Degand

Other partners: experts in computational linguistics and discourse from 24 countries

France MC members: Laurence Danlos and Philippe Muller (IRIT)

Abstract: With partners from across Europe, TextLink will unify numerous but scattered linguistic resources on discourse structure. With its resources searchable by form and/or meaning and a source of valuable correspondences, TextLink will enhance the experience and performance of human translators, lexicographers, language technology and language learners alike.

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Informal International Partners

Alpage has active collaborations with several international teams. The most active in 2014 have been:

- collaboration with Columbia University (United States), in particular on discourse modeling (Laurence Danlos, with Owen Rambow) and on computational morphology (Benoît Sagot, with Owen Rambow)
- collaboration with the Emory University (USA) on broad coverage parsing of unlabeled and noisy Korean data set (Djamé Seddah, with Jinho D. Choi).
- collaboration with the Indiana University (United States) on parsing morphologically rich languages (Djamé Seddah, with Sandra Kubler)
- collaboration with the University of Ljubljana (Slovenia) on wordnet development (Benoît Sagot, with Darja Fišer)
- collaboration with the Uppsala University (Sweden) on statistical parsing (Marie-Hélène Candito and sDjamé Seddah, with Joakim Nivre)
- collaboration with the Weizmann Institute of Science (Israel) on parsing morphologically rich languages (Djamé Seddah, with Reut Tsarfaty)

8.4. International Research Visitors

8.4.1. Visits of International Scientists

James Pustejovsky from Brandeis University (Boston, USA) was invited Professor at Alpage in April 2014. His stay was funded by Inria, his travel by Alpage. He is specialist in computational semantics and the creator of the "Generative Lexicon". During his stay in Paris, he gave two lectures with a large audience. The topic was on the computational model of events. The notion of event has long been central for both modeling the semantics of natural language as well as reasoning in goal-driven tasks in artificial intelligence. James outlined a unified theory of event structure. James has also been working with Alpage members. First on the French lexical resources developed at Alpage, namely Framenet (Marie Candito) and Verbenet (Laurence Danlos). Second on the role of attributions in discourse structure within the linguistic work made at Alpage for the ANR Polymnie (Laurence Danlos and Julie Hunter).

8.4.1.1. Internships

Kristina Gulordava is a visiting research student from the University of Geneva (LATL) supervised by Paola Merlo, visting ALPAGE from September 2014 to January 2015. Her Phd thesis is dedicated to the study of generic cross linguistic constraints across languages. Her goal is to investigate the connection between the quantitative aspects of word order variation across languages and the quantitative aspects of word order variation within a language. She explores to which extent a computational corpus-based analysis can provide new evidence not only for empirical, but also for theoretical linguistic research.

<p style="text-align:center;color:red;font-weight:bold;">RITS Team</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR

8.1.1.1. COCOVEA

Title: Coopération Conducteur-Véhicule Automatisé

Instrument: ANR

Duration: November 2013 - April 2017

Coordinator: Jean-Christophe Popieul (LAMIH - University of Valenciennes)

Partners: LAMIH, IFSTTAR, Inria, University of Caen, COMETE, PSA, CONTINENTAL, Valeo, AKKA Technologies, SPIROPS

Inria contact: Fawzi Nashashibi

Abstract: CoCoVeA project aims at demonstrating the need to integrate from the design of the system, the problem of interaction with the driver in resolving the problems of sharing the driving process and the degree of freedom, authority, level of automation, prioritizing information and managing the operation of the various systems. This approach requires the ability to know at any moment the state of the driver, the driving situation in which he finds himself, the operating limits of the various assistance systems and from these data, a decision regarding activation or not the arbitration system and the level of response.

8.1.2. FUI

8.1.2.1. Sinetic

Title: Système Intégré Numérique pour les Transports Intelligents Coopératifs

Instrument: FUI

Duration: December 2014 - May 2017

Coordinator: Thomas Nguyen (Oktal)

Partners: Oktal, ALL4TEC, CIVITEC, Dynalogic, Inria, EURECOM, Renault, Armines, IFSTTAR, VeDeCoM

Inria contact: Jean-Marc Lasgouttes

Abstract: The purpose of the project SINETIC is to create a complete simulation environment for designing cooperative intelligent transport systems with two levels of granularity: the system level, integrating all the components of the system (vehicles, infrastructure management centers, etc.) and its realities (terrain, traffic, etc.) and the component-level, modeling the characteristics and behavior of the individual components (vehicles, sensors, communications and positioning systems, etc.) on limited geographical areas, but described in detail.

8.1.3. Competitivity Clusters

RITS team is a very active partner in the competitivity clusters, especially MOV'EO and System@tic. We are involved in several technical committees like the DAS SUR of MOV'EO for example. RITS is also the main Inria contributor in the VeDeCoM institute (IEED). VeDeCoM is financing the PhD theses of Pierre Merdrignac, Younes Bouchaala, Fernando Garrido Carpio and Zayed Alsayed.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CATS

Type: FP7

Instrument: Specific Targeted Research Project

Duration: January 2010 - December 2014

Coordinator: Lohr Industrie (France)

Partner: Inria (France), CTL (Italy), EPFL (Switzerland), TECHNION (Israel), GEA (Switzerland), ERT (France), and the cities of Formello (Italy), Strasbourg (France) and Ploiesti (Romania).

Inria contact: Michel Parent

Abstract: CATS' aim is the full development and experimentation of a new urban transport service based on a new generation of vehicle. Its major innovation is the utilization of a single type of vehicle for two different uses: individual use or semi collective transport. This new transport service is aimed at filling the gap between public mass transport and private individual vehicles.

See also: http://www.cats-project.org

8.2.1.2. FURBOT

Type: FP7

Instrument: Specific Targeted Research Project

Duration: November 2011 - February 2015

Coordinator: Genova University (Italy

Partner: Bremach (Italy), ZTS (Slovakia), Universite di Pisa (Italy), Persico (Italy), Mazel (Spain), TCB (Portugal), Inria (France).

Inria contact: Fawzi Nashashibi

Abstract: The project proposes novel concept architectures of light-duty, full-electrical vehicles for efficient sustainable urban freight transport and will develop FURBOT, a vehicle prototype, to factually demonstrate the performance expected.

8.2.1.3. CityMobil2

Type: COOPERATION (TRANSPORTS)

Instrument: Large-scale integrating project

Duration: September 2012 - August 2016

Coordinator: University of Rome La Sapienza, CTL (Italy)

Partner: Inria (France), DLR (germany), GEA Chanard (Switzerland), POLIS (Belgium), ERT (Belgium), EPFL (Switzerland),...(45 partners!)

Inria contact: Fawzi Nashashibi

Abstract: The CityMobil2 goal is to address and to remove three barriers to the deployment of automated road vehicles: the implementation framework, the legal framework and the unknown wider economic effect. CityMobil2 features 12 cities which will revise their mobility plans and adopt wherever they will prove effective automated transport systems. Then CityMobil2 will select the best 5 cases (among the 12 cities) to organize demonstrators. The project will procure two sets of automated vehicles and deliver them to the five most motivated cities for a 6 to 8 months demonstration in each city. CityMobil2 will establish a workgroup that will deliver a proposal for a European Directive to set a common legal framework to certify automated transport systems.

See also: http://www.citymobil2.eu/en/

8.2.1.4. Mobility2.0

Title: Co-operative ITS systems for enhanced electric vehicle mobility

Type: COOPERATION (TRANSPORTS)

Duration: September 2012 - February 2015

Coordinator: Broadbit (Slovakia)

Partner: ETRA (Spain), Barcelona Digital (Spain), ICCS (Greece), MRE (Italy), Armines (France), University of Twente (Netherlands), Privé (Italy), NEC (United Kingdom)

Inria contact: Jean-Marc Lasgouttes

Abstract: Mobility2.0 will develop and test an in-vehicle commuting assistant for FEV mobility, resulting in more reliable and energy-efficient electro-mobility. In order to achieve a maximum impact, Mobility2.0 takes an integrated approach of addressing the main bottlenecks of urban FEV mobility: "range anxiety" related to the limited FEV range, scarcity of parking spaces with public recharging spots, and the congestion of urban roads. Our integrated approach means the application developed by Mobility2.0 will utilize co-operative systems to simultaneously consider these bottlenecks, so that such an optimization can be achieved which still guarantees reliable transportation for each FEV owner. Mobility2.0 will focus on assisting the daily urban commute, which represents the bulk of urban mobility.

See also: http://mobility2.eu/

8.2.1.5. DESERVE

Title: DEvelopment platform for Safe and Efficient dRiVE

Duration: September 2012 - August 2015

Coordinator: VTT (Finland)

Partner: CRF (Italy), Armines (France), CONTINENTAL AUTOMOTIVE FRANCE SAS (France), FICOSA (Italy), Inria (France), TRW (Great Britain), AVL (Austria), BOSCH (Germany), DAIMLER (Germany), VOLVO (Sweden),...(26 partners)

Inria contact: Fawzi Nashashibi

Abstract: To manage the expected increase of function complexity together with the required reduction of costs (fixed and variable) DESERVE will design and build an ARTEMIS Tool Platform based on the standardization of the interfaces, software (SW) reuse, development of common non-competitive SW modules, and easy and safety-compliant integration of standardized hardware (HW) or SW from different suppliers. With innovative design space exploration (DSE) methods system design costs can be reduced by more than 15%. Hence, DESERVE will build an innovation ecosystem for European leadership in ADAS embedded systems, based on the automotive R&D actors, with possible applications in other industrial domains.

See also: http://www.artemis-ju.eu/project/index/view?project=38

8.2.1.6. AutoNet2030

Title: Co-operative Systems in Support of Networked Automated Driving by 2030

Duration: November 2013 – October 2016

Coordinator: Andras KOVACS – BROADBIT (Hungary)

Partner: BROADBIT (Hungary), BASELABS (Germany), CRF (Italy), Armines (France), VOLVO (Sueden), HITACHI EUROPE (France), EPFL (Switzerland), ICCS (Greece), TECHNISCHE UNIVERSITAET DRESDEN (Germany) (9 partners)

Inria contact: Fawzi Nashashibi

Abstract: AutoNet2030 shall develop and test a co-operative automated driving technology, based on a decentralized decision-making strategy which is enabled by mutual information sharing among nearby vehicles. The project is aiming for a 2020-2030 deployment time horizon, taking into account the expected preceding introduction of co-operative communication systems and sensor based lane-keeping/cruise-control technologies. By taking this approach, a strategy can be worked out for the gradual introduction of fully automated driving systems, which makes the best use of the widespread existence of co-operative systems in the near-term and makes the deployment of fully automated driving systems beneficial for all drivers already from its initial stages.

See also: http://www.autonet2030.eu/

8.2.2. Collaborations with Major European Organizations

- RITS is member of the **euRobotics AISBL** and the Leader of *"People transport"* Topic. This makes from Inria one of the rare French robotics representatives at the European level.

- RITS is a full partner of **VRA**: VRA – Vehicle and Road Automation is a support action funded by the European Union to create a collaboration network of experts and stakeholders working on deployment of automated vehicles and its related infrastructure. VRA project is considered as the cooperation interface between EC funded projects, international relations and national activities on the topic of vehicle and road automation. It is financed by the European Commission DG CONNECT and coordinated by ERTICO – ITS Europe.

- RITS is member of the Working Group on Automation: **iMobility**. This group has been created and is animated by ERTICO ITS Europe. The Automation Working Group was formed under the iMobility Forum, with the initial high level aims of exploring and promoting the potential of highly automated vehicles and applications and working towards the development of a roadmap for the deployment of automated systems.

8.3. International Initiatives

8.3.1. Informal International Partners

In the following we are highlighting only some selected collaborations, partners with whom there are: signed MoU's, researchers exchanges, softwares and hardwares exchanges, scientific close collaboration, etc.

- *NAIST – Japan* The RITS team has a close cooperation with NAIST (Nara institute of Science and Technology), Japan since 2009. Based on this collaboration NAIST and Inria established the MoU agreement to accelerate and strengthen future research collaborations and the exchange of researchers and students (4 Japanese researchers were hosted by IMARA/RITS since 2012).

- *University of Zaragoza – Spain* The team has strong collaborations with University of Zaragoza, Spain, especially the Intelligent Networks and Information Technologies group (INIT) directed by Prof. Francisco J. Martinez Domingues. Professor Martinez and Professor Piedad had a 3 months stay at Inria in summer 2014 during which closer collaborations and joint publications and a workshop co-organization was agreed on.

- CNIT (Consorzio Nazionale Inter-unviversitario per le Telecomunicazioni), Italy, directed by Professor Paolo Pagano, and University of Western Ontario, especially the department of the Electrical & Computer Engineering.

- *SwRI – USA*: Since 2007, a collaboration agreement exists with the Southwest Research Institute (San Antonio, Texas, USA) for the joint development of autonomous vehicle technologies, focusing on the areas of perception, intelligence, command and control, communications, platforms and safety. SwRI is one of the oldest and largest nonprofit applied research and development organizations in the U.S. The partnership conducted joint researches and exchanged intellectual properties to foster rapid technology and system advancements in vehicle autonomy. A joint vehicle demonstration took place in 2009 during the ITS World Congress in London.

- *Shanghai Jiao Tong University (SJTU) – China*: Professor Ming Yang is now leading Department of Automation in SJTU. Previously he has been a Post-doc fellow at Inria (IMARA/RITS team) from 2003 to 2005. Thus he shares RITS research areas and his main research activities are around the development of intelligent Cybercars. Several researchers and graduate students from SJTU were hired by RITS in the past. Both teams are partners of several joint French-Asian collaborative projects (e.g., CityHome, PAMM,...). Prof. Ming Yang Lab, RITS and e-Motion are currently discussing seriously the creation of an Inria International Research Lab., a common lab focusing on the topic of mobile robotics (including Intelligent Vehicles and Assistive Robotics). M. Hao Li, recently awarded PhD from Mines ParisTech under the supervision of Fawzi Nashashibi (RITS), is also a former student of Prof. Yang. He will be helping in the coordination of this new partnership project.

- *MICA LAB – Vietnam*: a growing partnership is under construction with MICA Lab under the co-direction of M. Eric Castelli. Partners in joint French-Asian projects, RITS and MICA lab have submitted an application to the Vietnamese Program 911 to support the financing of a joint PhD thesis.

- Institut du transport avancé du Québec (ITAQ) – Canada ITAQ wishes to conduct a project on the guidance of electric and hybrid semi-autonomous and autonomous applications for off-road vehicles. They want to develop this project in close collaboration with several Quebec companies and universities / colleges in Quebec (University of Sherbrooke-CRVI), France (Inria) and the United States (MIT). ITAQ holds expertise in electric vehicles but wants to develop its capacity for research in robotics, artificial intelligence, autonomous vehicles, etc. For this reason, a partnership is under construction (MoU) with Inria and especially with RITS to identify all the ways in which we could work together closely in order to transfer knowledge and expertise.

- *International Chaire "GAT"*: Inria-RITS, Mines ParisTech, EPFL, Univ. of Berkeley (PATH Program) and Shanghai Jiao Tong Univ. (SJTU) are the academic partners of the international Chaire GAT, funded and supported by: Valeo Group, SAFRAN Group and MPSA Group (Peugeot-Citroën). A recent NDA has been signed recently. This Chaire will promote and fund academic activities related to Ground Automated Transportation and autonomous driving.

- *Technical University of Sophia – Bulgaria*: RITS is conducting a close partnership with the Technical University of Sophia (Department of Mechanical Engineering). Since 2009, Professor Plamen Petrov has been a visiting professor at Inria. He contributed in conducting common advanced researches with RITS researchers in the field of dynamic modeling and adaptive motion control for vehicles and robots. Joint works have been also driven to develop and validate platooning concepts for normal speed driving of automated vehicles. This collaboration will continue with further scientific challenges to tackle especially in the field of vehicle control and motion planning.

8.3.2. Participation In other International Programs

- *STIC-Asia – French-Asian cooperation*: in the context of the Asian-French projects CityHome and PAMM, very close collaboration were driven between Inria's IMARA/RITS and E-Motion project-teams and Asian laboratories such as: NTU (Singapore), Dept. of Computer Science and Electrical Engineering Graduate School of Science and Technology Kumamoto University (Japan), Department of Automation of the Shanghai Jiao Tong University (SJTU University, China) and the Information and Communication Engineering and the Intelligent Systems Research Center at the SungKyunKwan University (SKKU), (Korea). Two cooperation projects were conducted together: CityHome (ended in 2011) and PAMM (ended in 2014). A new collaborative project has been recently accepted under the coordination of F. Nashashibi, head of RITS (SIM-Cities project [0]).

- *ECOS NORD – Simon Bolivar University (Venezuela)*: RITS and University of Simon Bolivar have started an official privileged cooperation under the framework of the ECOS Nord international Program. This program started effectively in 2014 with the expected visit of two researchers and a

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[0]Sustainable Intelligent Mobility for smart Cities

PhD student from each institute to the other institute. Collaborations between our institutions started already in 2012. Since this date, one researcher and 7 engineers (trainees) from SBU made several months stay each at RITS. They all worked in the field of intelligent control.

8.4. International Research Visitors

8.4.1. Visits of International Scientists

- **Prof. Plamen PETROV**: professor at the Technical University of Sofia (Bulgaria). He has been an invited professor at Inria from June to September 2014. Prof. Petrov's visit is the sixth of its kind since 2009. This close collaboration in the area of automatic control has very fruitful results and outcomes. This year's joint research topic dealt with the design and implementation of saturated control for automated parking maneuvers (cf. section 6.9). In validation to 2013 activities, two articles were published in 2014: [28] and [44].

- **Dr. Maria Piedad Garrido Picazo and Dr. Francisco Jose Martinez Dominguez**: assistant professors of the University of Zaragoza, invited from June until September 2014. During their visit, they worked on routing and multicast issues in VANET.

8.4.1.1. Internships

- **Wei Lin Ku**: master student at National Chiao Tung University (Hsinchu, Taiwan). He has been an Inria intership student from April until October 2014. During this period, he studied and developed several DPM based strategies to detect and classify road obstacles (cars, pedestrians,...).

- **Mickaël Bergem, Hugues Thomas, Roxane Delpeyrat, Laurent Laflèche**: 2nd year at ENPC. They had a group project on reactive path planning using potential fields from April to June 2014.

- **Carlos Eduardo Flores Pino, Giampaolo Otero Ridolfi, Luis Guillermo Roldao Jimenez, Jean Carlos Rivera Pabon**: they worked on different methods for improving energy consumption of urban vehicles.

- **Leopoldo Gonzalez Clarembaux**: He was in master 2 at Telecom Paris-Sud (Evry). He developed perception and control strategies for autonomous docking for the electric freight vehicle Furbot. His work was implemented in simulation and on our Cybus platform.

8.4.2. Visits to International Teams

8.4.2.1. Research stays abroad

Guy Fayolle has been invited two weeks (5-19 oct. 2014) at Heriot-Watt University, Edinburgh (Prof. S. Foss, math. dept.).

<p align="center" style="color:red">**SMIS Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR KISS (Dec. 2011 - Dec. 2015)

Partners: Inria-SMIS (coordinator), Inria-SECRET, LIRIS, Univ. of Versailles, CryptoExperts, Gemalto, Yvelines district.
SMIS funding: 230k€.

The idea promoted in KISS is to embed, in trusted devices, software components capable of acquiring, storing and managing securely various forms of personal data (e.g., salary forms, invoices, banking statements, geolocation data, depending on the applications). These software components form a Personal Data Server which can remain under the holder's control. The scientific challenges include: embedded data management issues tackling regular, streaming and spatio-temporal data (e.g., geolocation data), data provenance-based privacy models, crypto-protected distributed protocols to implement private communications and secure global computations.

8.1.2. CAPPRIS Project-Lab (Dec. 2011 - Dec. 2015)

Inria Partners: PRIVATICS (coordinator), SMIS, PLANETE, CIDRE, COMETE.
External partners: Univ. of Namur, Eurecom, LAAS.
Funding: not associated to individual project-teams.

An Inria Project Lab (IPL) is a long-term multi-disciplinary project launched by Inria to sustain large scale risky research actions in line with its own strategic plan. CAPPRIS stands for "Collaborative Action on the Protection of Privacy Rights in the Information Society". The key issues that are addressed are: (1) the identification of existing and future threats to privacy, (2) the definition of formally grounded measures to assess and quantify privacy, (3) the definition of the fundamental principles underlying privacy by design and methods to apply them in concrete situations and (4) The integration of the social and legal dimensions. To assess the relevance and significance of the research results, they are confronted to three classes of case studies CAPPRIS partners are involved in: namely Online Social Networks, Location Based Services and Electronic Health Record Systems.

8.1.3. PEPS PAIP (Pour une Approche Interdisciplinaire de la Privacy) (Sept. 2013 - Sept. 2014)

Partners: ADIS and SMIS (co-organizers), CERDI, DANTE, COMETE, GRACE, TPT, LIMSI.
Funding: 30K€ from CNRS, not associated to individual project-teams.

The Digital Society Institute (DSI) is the UPSa IDEX catalyst for multidisciplinary research on societal challenges inherent to eLife/life digitization. DSI plans to be one of the European leading institutes fostering multidisciplinary research across ICTS and SHES. In 2013 DSI already hosts two kick-off major research projects : (1) Human and Machine Coevolution and (2) Privacy/digital identities. ADIS and SMIS are co-organizing project (2) on data privacy. The PEPS PAIP is part of project (2) and aims at fostering the cooperation between lawyers, economists and computer scientists on privacy issues, through the organization of brainstorming days and workshops and a study of possible joint experiments of privacy preserving applications.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. PDS4NRJ (Aug. 2013 - Aug. 2014)

Instrument: Marie Curie Intra-European Fellowships for Career Development

Duration: 2013 Aug. - 2014 Aug.

Inria contact: Philippe Bonnet

This project, called PDS4NRJ, is based on the insights that (a) secure personal data management can be radically improved with the advent of secure hardware embedded on personal devices at the edges of the Internet, and (b) that a secure personal data management infrastructure should be applied in the context of smart buildings. Our overall objective is to define a new form of decentralized infrastructure for sharing smart meter data with access and usage control guarantees. The PDS4NRJ project is a unique opportunity for Philippe Bonnet, currently associate professor at ITU (Denmark), to become a leading expert in the field of secure personal data management thanks to a tight cooperation with SMIS members.

8.2.2. Collaborations in European Programs, except FP7

Program: Danish Council for Independent Research (FTP call)

Project acronym: CLyDE

Project title: Cross-LaYer optimized Database Engine

Duration: 10/2011 - 10/2014

Partners: IT University of Copenhagen (Denmark), SMIS

Abstract: The goal is to explore how flash devices, operating system and database system can be designed together to improve overall performance. Such a co-design is particularly important for the next generation database appliances, or cloud-based relational database systems for which well suited flash components must be specified. More generally, our goal is to influence the evolution of flash devices and commodity database systems for the benefit of data intensive applications. The project should result in two complementary open-source software systems: (i) a bimodal flash device software component based on the idea from [30], and (ii) a database system optimized for bimodal flash devices. The project funding is managed by the IT University of Copenhagen and covers the expenses for two co-supervised PhD students (including regular visits to and from Denmark).

8.2.3. Collaborations with Major European Organizations

The SMIS members have developed tight European cooperations with the following persons/teams:

Philippe Bonnet (Associate Professor at the University of Copenhagen, Denmark)

Collaboration on Flash-based data management for high-end servers with Philippe Bonnet from IT University of Copenhagen and Björn Þór Jónsson from Reykjavík University (see Section 8.2.2). The study of flash devices started during a short sabbatical of Luc Bouganim (from April to August 2008) in Copenhagen.

Michalis Vazirgiannis (Athens University of Economics and Business)

Collaboration on Minimal Exposure in the context of Michalis' Digiteo Chair at LIX (Ecole Polytechnique).

8.3. International Research Visitors

Philippe Bonnet, associate professor at the IT University of Copenhagen, visited SMIS in the context of a Marie Curie grant from August 2013 until July 2014 (see Section 8.2.1.1).

<p align="center" style="color:red;">**WILLOW Project-Team**</p>

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. *Agence Nationale de la Recherche (ANR): SEMAPOLIS*

Participants: Mathieu Aubry, Josef Sivic.

The goal of the SEMAPOLIS project is to develop advanced large-scale image analysis and learning techniques to semantize city images and produce semantized 3D reconstructions of urban environments, including proper rendering. Geometric 3D models of existing cities have a wide range of applications, such as navigation in virtual environments and realistic sceneries for video games and movies. A number of players (Google, Microsoft, Apple) have started to produce such data. However, the models feature only plain surfaces, textured from available pictures. This limits their use in urban studies and in the construction industry, excluding in practice applications to diagnosis and simulation. Besides, geometry and texturing are often wrong when there are invisible or discontinuous parts, e.g., with occluding foreground objects such as trees, cars or lampposts, which are pervasive in urban scenes. This project will go beyond the plain geometric models by producing semantized 3D models, i.e., models which are not bare surfaces but which identify architectural elements such as windows, walls, roofs, doors, etc. Semantic information is useful in a larger number of scenarios, including diagnosis and simulation for building renovation projects, accurate shadow impact taking into account actual window location, and more general urban planning and studies such as solar cell deployment. Another line of applications concerns improved virtual cities for navigation, with object-specific rendering, e.g., specular surfaces for windows. Models can also be made more compact, encoding object repetition (e.g., windows) rather than instances and replacing actual textures with more generic ones according to semantics; it allows cheap and fast transmission over low- bandwidth mobile phone networks, and efficient storage in GPS navigation devices.

This is a collaborative effort with LIGM / ENPC (R. Marlet), University of Caen (F. Jurie), Inria Sophia Antipolis (G. Drettakis) and Acute3D (R. Keriven).

8.2. European Initiatives

8.2.1. *European Research Council (ERC) Advanced Grant: "VideoWorld" - Jean Ponce*

Participants: Jean Ponce, Ivan Laptev, Josef Sivic.

WILLOW will be funded in part from 2011 to 2015 by the ERC Advanced Grant "VideoWorld" awarded to Jean Ponce by the European Research Council.
This project is concerned with the automated computer analysis of video streams: Digital video is everywhere, at home, at work, and on the Internet. Yet, effective technology for organizing, retrieving, improving, and editing its content is nowhere to be found. Models for video content, interpretation and manipulation inherited from still imagery are obsolete, and new ones must be invented. With a new convergence between computer vision, machine learning, and signal processing, the time is right for such an endeavor. Concretely, we will develop novel spatio-temporal models of video content learned from training data and capturing both the local appearance and nonrigid motion of the elements—persons and their surroundings—that make up a dynamic scene. We will also develop formal models of the video interpretation process that leave behind the architectures inherited from the world of still images to capture the complex interactions between these elements, yet can be learned effectively despite the sparse annotations typical of video understanding scenarios. Finally, we will propose a unified model for video restoration and editing that builds on recent advances in sparse coding and dictionary learning, and will allow for unprecedented control of the video stream. This project addresses fundamental research issues, but its results are expected to serve as a basis for groundbreaking technological advances for applications as varied as film post-production, video archival, and smart camera phones.

8.2.2. European Research Council (ERC) Starting Grant: "Activia" - Ivan Laptev
Participant: Ivan Laptev.

WILLOW will be funded in part from 2013 to 2017 by the ERC Starting Grant "Activia" awarded to Ivan Laptev by the European Research Council.
Computer vision is concerned with the automated interpretation of images and video streams. Today's research is (mostly) aimed at answering queries such as "Is this a picture of a dog?", "Is the person walking in this video?" (image and video categorisation) or sometimes "Find the dog in this photo" (object detection). While categorisation and detection are useful for many tasks, inferring correct class labels is not the final answer to visual recognition. The categories and locations of objects do not provide direct understanding of their function, i.e., how things work, what they can be used for, or how they can act and react. Neither do action categories provide direct understanding of subject's intention, i.e., the purpose of his/her activity. Such an understanding, however, would be highly desirable to answer currently unsolvable queries such as "Am I in danger?" or "What can happen in this scene?". Answering such queries is the aim of this project.

The main challenge is to uncover the functional properties of objects and the purpose of actions by addressing visual recognition from a different and yet unexplored perspective. The major novelty of this proposal is to leverage observations of people, i.e., their actions and interactions to automatically learn the use, the purpose and the function of objects and scenes from visual data. This approach is timely as it builds upon two key recent technological advances: (a) the immense progress in visual object, scene and human action recognition achieved in the last ten years, and (b) the emergence of massive amounts of image and video data readily available for training visual models. My leading expertise in human action recognition and video understanding puts me in a strong position to realise this project. ACTIVIA addresses fundamental research issues in automated interpretation of dynamic visual scenes, but its results are expected to serve as a basis for ground-breaking technological advances in practical applications. The recognition of functional properties and intentions as explored in this project will directly support high-impact applications such as prediction and alert of abnormal events and automated personal assistance, which are likely to revolutionise today's approaches to crime protection, hazard prevention, elderly care, and many others.

8.2.3. European Research Council (ERC) Starting Grant: "Leap" - Josef Sivic
Participant: Josef Sivic.

The contract has begun on Nov 1st 2014. WILLOW will be funded in part from 2014 to 2018 by the ERC Starting Grant "Leap" awarded to Josef Sivic by the European Research Council.
People constantly draw on past visual experiences to anticipate future events and better understand, navigate, and interact with their environment, for example, when seeing an angry dog or a quickly approaching car. Currently there is no artificial system with a similar level of visual analysis and prediction capabilities. LEAP is a first step in that direction, leveraging the emerging collective visual memory formed by the unprecedented amount of visual data available in public archives, on the Internet and from surveillance or personal cameras - a complex evolving net of dynamic scenes, distributed across many different data sources, and equipped with plentiful but noisy and incomplete metadata. The goal of this project is to analyze dynamic patterns in this shared visual experience in order (i) to find and quantify their trends; and (ii) learn to predict future events in dynamic scenes. With ever expanding computational resources and this extraordinary data, the main scientific challenge is now to invent new and powerful models adapted to its scale and its spatio-temporal, distributed and dynamic nature. To address this challenge, we will first design new models that generalize across different data sources, where scenes are captured under vastly different imaging conditions such as camera viewpoint, temporal sampling, illumination or resolution. Next, we will develop a framework for finding, describing and quantifying trends that involve measuring long-term changes in many related scenes. Finally, we will develop a methodology and tools for synthesizing complex future predictions from aligned past visual experiences. Our models will be automatically learnt from large-scale, distributed, and asynchronous visual data, coming from different sources and with different forms of readily-available but noisy and incomplete metadata such as text, speech, geotags, scene depth (stereo sensors), or gaze and body motion (wearable sensors). Breakthrough progress on these problems would have profound implications on our everyday lives as well as science and

commerce, with safer cars that anticipate the behavior of pedestrians on streets; tools that help doctors monitor, diagnose and predict patients' health; and smart glasses that help people react in unfamiliar situations enabled by the advances from this project.

8.2.4. EIT-ICT labs: Mobile visual content analysis (Inria)

Participants: Ivan Laptev, Josef Sivic.

The goal of this project within the European EIT-ICT activity is to mature developed technology towards real-world applications as well as transfer technology to industrial partners. Particular focus of this project is on computer vision technology for novel applications with wearable devices. The next generation mobile phones may not be in the pocket but worn by users as glasses continuously capturing audio-video data, providing visual feedback to the user and storing data for future access. Automatic answers to "Where did I leave my keys yesterday?" or "How did this place look like 100 years ago?" enabled by such devices could change our daily life while creating numerous new business opportunities. The output of this activity is new computer vision technology to enable a range of innovative mobile wearable applications.

This is a collaborative effort with S. Carlsson (KTH Stockholm) and J. Laaksonen (Aalto University).

8.3. International Initiatives

8.3.1. IARPA FINDER Visual geo-localization (Inria)

Participants: Josef Sivic, Petr Gronat, Relja Arandjelovic.

Finder is an IARPA funded project aiming to develop technology to geo-localize images and videos that do not have geolocation tag. It is common today for even consumer-grade cameras to tag the images that they capture with the location of the image on the earth's surface ("geolocation"). However, some imagery does not have a geolocation tag and it can be important to know the location of the camera, image, or objects in the scene. Finder aims to develop technology to automatically or semi-automatically geo-localize images and video that do not have the geolocation tag using reference data from many sources, including overhead and ground-based images, digital elevation data, existing well-understood image collections, surface geology, geography, and cultural information.

Partners: ObjectVideo, DigitalGlobe, UC Berkeley, CMU, Brown Univ., Cornell Univ., Univ. of Kentucky, GMU, Indiana Univ., and Washington Univ.

8.3.2. Inria Associate Team VIP

Participants: Ivan Laptev, Josef Sivic.

This project brings together three internationally recognized research groups with complementary expertise in human action recognition (Inria), qualitative and geometric scene interpretation (CMU) and large scale object recognition and human visual perception (MIT). The goal of VIP (Visual Interpretation of functional Properties) is to discover, model and learn functional properties of objects and scenes from image and video data.

Partners: Aude Oliva (MIT) and Alexei Efros (CMU / UC Berkeley). The project will be funded during 2012-2014.

8.3.3. Inria International Chair - Prof. John Canny (UC Berkeley)

Participants: John Canny [UC Berkeley], Jean Ponce, Ivan Laptev, Josef Sivic.

Prof. John Canny (UC Berkeley) has been awarded the Inria International chair in 2013. He has visited Willow during three months in 2014.

8.3.4. Inria CityLab initiative

Participants: Josef Sivic, Jean Ponce, Ivan Laptev, Alyosha Efros [UC Berkeley].

Willow participates in the ongoing CityLab@Inria initiative (co-ordinated by V. Issarny), which aims to leverage Inria research results towards developing "smart cities" by enabling radically new ways of living in, regulating, operating and managing cities. The activity of Willow focuses on urban-scale quantitative visual analysis and is pursued in collaboration with A. Efros (UC Berkeley).

Currently, map-based street-level imagery, such as Google Street-view provides a comprehensive visual record of many cities worldwide. Additional visual sensors are likely to be wide-spread in near future: cameras will be built in most manufactured cars and (some) people will continuously capture their daily visual experience using wearable mobile devices such as Google Glass. All this data will provide large-scale, comprehensive and dynamically updated visual record of urban environments.

The goal of this project is to develop automatic data analytic tools for large-scale quantitative analysis of such dynamic visual data. The aim is to provide quantitative answers to questions like: What are the typical architectural elements (e.g., different types of windows or balconies) characterizing a visual style of a city district? What is their geo-spatial distribution (see figure 1)? How does the visual style of a geo-spatial area evolve over time? What are the boundaries between visually coherent areas in a city? Other types of interesting questions concern distribution of people and their activities: How do the number of people and their activities at particular places evolve during a day, over different seasons or years? Are there tourists sightseeing, urban dwellers shopping, elderly walking dogs, or children playing on the street? What are the major causes for bicycle accidents?

Break-through progress on these goals would open-up completely new ways smart cities are visualized, modeled, planned and simulated, taking into account large-scale dynamic visual input from a range of visual sensors (e.g., cameras on cars, visual data from citizens, or static surveillance cameras).

8.4. International Research Visitors

8.4.1. *Visits of International Scientists*

Prof. Alexei Efros (UC Berkeley) has visited Willow for one month in 2014. Prof. John Canny (UC Berkeley) has visited Willow during three months in 2014 within the framework of Inria's International Chair program.

8.4.1.1. Internships

Stefan Lee (Indiana University) has been a visiting PhD student at Willow since May 2014. Yumin Suh (Seoul National University) has been a visiting PhD student at Willow since Dec. 2014.